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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Iron and Steel Tariff Position

There has been considerable pressure for an increased duty on imports of iron and steel, and it is expected that a decision may be announced some time during the present month. Those opposed to the increase were asked to express their views by the middle of February, and it does not appear that there is any organised resistance. We have previously pointed out that the increased output and consumption in the home market has led to largely increased imports and that this was the one unsatisfactory feature in the present position. The increase was of the order of 50 per cent. in tonnage. Part of this increase came from British countries overseas which would in any case not be interfered with, such as Indian pig-iron, and practically the whole of the remainder comes from the Continent, the bulk of it being products which the industry is quite capable of turning out in this country. It is of interest to note that in 1933, the first year in which the tariff checked the import of iron and steel, over half the imports came from Belgium, but that country has not quite shared in the increase in 1934 to the same extent. Those who are pressing for the increased duty suggest that the circumstances demand it being advanced from 33⅓ per cent. to 50 per cent. There is little doubt that the opposition, while by no means negligible, is less than might have been anticipated two years ago.

The effect of the change pending has practically been confined to the trading in Continental imports, which is, of course, much quieter. The opposition naturally makes use of the damaging effect of increased prices on our competitive export trade, but now that the country is committed to a tariff on imports there seems to be no alternative but to go ahead with it and to rely on reduction of production costs in an assured home market to give importers the material they require at reasonably competitive prices. This means carrying to completion the ambitious scheme of reorganisation embarked upon by the British Iron and Steel Federation, in connection with which the appointment of Sir Andrew Duncan as independent chairman is an important feature. The Import Duties Advisory Committee can be trusted to look after the interests of the consuming public in their proper regard for the welfare of the country as a whole in relation to the tariff position. The foundry trade is, indirectly and directly, greatly concerned with these movements.

The Welding Symposium

Unless our counting is faulty, no less than one hundred and thirty-three Papers are to be presented to the Symposium on the Welding of Iron and Steel organised by the Iron and Steel Institute on May 2 and 3. Surely this must be the greatest number of contributions to a particular branch of knowledge ever assembled for presentation to one audience. It has only been rendered possible by the co-operation of a number of scientific and technical societies. The Institute of British Foundrymen is co-operating, and on its behalf Mr. V. C. Faulkner is to deal with the reclamation of automobile castings, and Mr. V. G. Pearson, of Edgar Allen & Company, on "Welding for the Steel-Casting Industry." Mr. J. G. Pearce, the director of the British Cast Iron Research Association, is reviewing the metallurgical considerations underlying the welding of cast iron. The whole field of welding is very thoroughly covered, and one wonders whether, after the conclusion of the symposium, there will be much to say about the subject for many years.

We are hoping that it will have a very profound influence on the foundry industry, by putting welding on exactly the same basis as the feeding of castings, as both have the same object in view, the former making for surface soundness and the latter internal solidity. If real pride were taken in the reclamation of castings and the department were converted into one of the "show" departments of the concern, then the buying authorities would be infinitely less censorious and, indeed, might share something of the enthusiasm exhibited by their suppliers. At the moment, so far as the foundry industry is concerned, the question of welding is tactfully excluded from conversations between the representatives of buyers and sellers wherever possible, but after the May meeting, good grounds should be established for a better understanding and the complete rationalisation of the subject. The founders, on their side, will have to discard all improvisations within the welding departments and install proper plant for preheating prior to welding and annealing subsequent thereto. Adequate plant will have to be installed for tackling the various types of defects, for there is no universal "best" welding process for reclaiming iron and steel castings. We are convinced that the larger foundries, by visualising the welding department as an independently-operated and properly-equipped shop, could make it pecuniarily profitable and good publicity for the quality of output.

XUM

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Magnetic Separation

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In reply to the criticism by Messrs. The Rapid Magnetting Machine Company, Limited, in your issue of February 28, whilst Rapid Magnetting machines may have been the first to be used in Great Britain, for the treatment of vitreous enamel, it is rather a bold statement to say that they have supplied practically all, as there is a considerable number of machines by other makers in operation.

I entirely agree that serrated edges incorporated in these machines are essential. My point is that they have the serrations in the wrong place for dealing with enamel slop, which is a totally different matter from dealing with potters' slip.

It may be of interest to your correspondents to know that the serrations on the bottom of the trough do definitely retard the flow of enamel on account of the added friction caused by these serrations.

Secondly, they must appreciate as electrical engineers that it is impossible to get as great a magnetic intensity with primary magnets as can be obtained by induction or secondary magnets of the correct design.

Another important point which must not be lost sight of is that in magnetic separators, with serrations on the bottom of the trough, the cleaning down is extremely difficult, and it is quite definite that the bottom serrations are not necessary when dealing with enamel slop; as stated in my Paper, only facts were given, and enamel slop was first treated over the new-type separator with machined surface and a quantity of iron oxide was extracted.

The same enamel was then passed over the machine with the double serrations, and no further residue was extracted, but a considerable amount of the enamel was retained in the separator. This fact causes me to doubt whether your correspondents have ever made tests on any other type of separator than those of their own.

It may be worth recording for those interested that the main advantages of the machine described in my Paper can be summarised as follow:—

(*a*) Prevents waste of enamel.
(*b*) Enables much stronger magnetic fields to be created for the same electrical input which results in higher efficiency of extraction.
(*c*) Facilitates magnetic adjustment mechanically without disturbing the electrical circuit.
(*d*) Is provided with means for controlling the flow of liquid.
(*e*) Is easier to clean down.
(*f*) Is cheaper in initial and running costs.

In the construction of the separator described in my Paper all the magnetic circuit is of steel, which enables greater magnetic flux to be generated, whereas in other types cast iron is used.

It has been found in practice that this new separator described in my Paper creates eddies through the serrations on the top induction or secondary bars, and this prevents iron from being washed down, and this machine can be run for a period equal to other types, without cleaning down being necessary.

The statement of the Rapid Magnetting Machine Company that the flow of material is adjusted by regulating the magnetic field is also definitely wrong, and evidently is a misunderstanding on their part. What I did say was that the set screws adjusted the flow of enamel and also the magnetic field.

The other mistake, pointed out as an obvious one by them, where the word "primary" is stated in lieu of "secondary" magnets, when dealing with hinged castings, needs no further comment, since it is obvious, with the exception that I would like to add that these hinged castings are so designed that they are easily removable for the purpose of washing in a bucket of water, if desired.

Yours, etc.,
J. T. GRAY.

5, Victoria Street, S.W.1.
March 11, 1935.

Effect of Copper upon Grey Cast Iron

In order to study the effect of copper upon the mechanical and physical properties of cast iron, E. Söhnchen and E. Piwowarsky* made several heats in an oil-fired crucible furnace. The composition of the iron base was 3.0 per cent. T.C. (circa), 2.2 to 2.6 Si, 0.7 Mn, 0.1 P, and 0.026 per cent. Sulphur. The copper content was varied from 0.56 to 1.92 per cent. Bars of different diameter were cast in sand and chill moulds. Some of the bars were fully annealed to obtain a ferritic structure. Copper in the percentage range investigated does not markedly affect either the quantity or the size of graphite. The graphite was lamellar in the sand-cast bars and granular in the chill-cast bars. In the annealed bars, precipitated copper particles were found, the quantity of which increased with increasing copper content. In the as-cast bars no copper particles could be detected. Tensile, transverse and shear strength increase up to 1.5 per cent. of copper, and then decrease. The deflection decreases continuously. The increase in strength must be attributed to the finely-divided copper particles. Subsequent annealing in the precipitation range of copper (400 to 600 deg. C.) gave no further increase in hardness, which shows that the bars had been fully age-hardened in the mould. The sensitiveness to wall-thickness of cast iron is not affected by copper. Under rolling friction the loss in weight was nearly the same with all copper contents, but substantially lower than with an unalloyed iron of the same composition. Under sliding friction (steel disc with water lubrication) the loss in weight continuously decreased with increasing copper content with both the annealed and as-cast bars. Thrice repeated heating and cooling between 650 and 975 deg. C. decreased the change in length with increasing copper content from about 0.9 to 0.8 per cent. The A_1-point is decreased up to 1.5 per cent. of copper.

Coercive force and remanence increase with increasing copper content in both the annealed and as-cast bars. The magnetic saturation is not affected. As an increase in coercive force by copper additions can only occur if the copper appears in the structure as a separated constituent it must be concluded that in the cast iron investigated copper begins to precipitate at between 0.5 and 1 per cent. The coercive force is further affected by the size of graphite, coarse graphite giving a low, and fine graphite a high coercive force. Thermal and electrical conductivity decrease up to about 1 per cent. of copper, and then increase. The electrical conductivity increases with decreasing particle size of graphite. The reverse is the case with the thermal conductivity. The co-efficient of expansion increases with increasing copper content. Copper does not affect the corrosion resistance of cast iron to the attack by tap and sea water, NaCl-solution and n/5 nitric acid. The corrosion in n/5 acetic acid is increased. The annealed chill-cast bars were always more attacked than the annealed sand-cast bars, which fact shows the detrimental effect of finely divided graphite upon the corrosion resistance.

* "Die Giesserei." 1934. Nos. 43-44.

Random Shots

Television is acumin in, so they say. This seems to "Marksman" an excellent opportunity for the rationalisation of technical Papers and lectures. The present system is one of flagrant decentralisation. Papers are delivered here and there to scattered audiences there and here. Important Papers, of course, are sometimes delivered several times to various branches. Now "Marksman" sees an opportunity in television. If only somebody would supply the necessary hundreds (or, I suppose, thousands) of pounds sterling, here is the chance of centralising the whole system. A private television transmitter, functioning from Deansgate or Wellington Street, could deliver the goods simultaneously to London, Manchester, Wales, Scotland, Sheffield, and Uncle Tom Cobbley and all. Not only would a flock, gaggle (or is it a fettle?) of foundrymen in the Outer Hebrides hear a real Diploma Paper, the last word on a ticklish metallurgical point, but they would have the ineffable pleasure of seeing the lecturer himself, already a household name to them through the columns of the FOUNDRY TRADE JOURNAL. With bated breath they could watch him gargling, clearing his throat, throwing out his manly chest, breathing deeply and rhythmically and finally trying out his mellow bass on a preliminary tonic sol-fa.

* * *

A television transmitter is to be erected on the summit of Brocken, the highest peak in the Harz Mountains in Germany. The reason for the choice of this site is that since ultra-short waves have a range which is limited to the optical path, it is necessary to install the transmitter on the highest point available. To those with a taste for the ghoulish, the name "Brocken" will probably mean something. The Brocken Mountain, in fact, means much the same to students of Black Magic and ghostly walking as the name of Mecca means to the Agha Khan.

* * *

Brocken has the fearsome reputation of being haunted by wraiths of the most unpleasant kind. The witches gather there for the revels on Walpurgis Night, and a spectral giant walks amid the wreathing mists on its slopes. "Marksman" seems to remember a broadcast seance on the mountain top which proved a complete fiasco. No spectres presented themselves before the microphone. Surely a television audition will prove too much for their vanity. Now at last the reputation of Brocken will be put to the test.

* * *

"What time does the next train come in?" asked Edward, aged six, of the old rural station master.

"Why, you little rascal, I've told you five times that it comes in at 4.44."

"I know it," replied Edward, "but I like to see your whiskers wobble when you say 4.44."

* * *

They had been sitting in the swing in the moonlight alone. No word broke the stillness for half an hour until—

"Suppose you had money," she said, "what would you do?"

He threw out his chest in all the glory of young manhood. "I'd travel!"

He felt her warm, young hand slide into his. When he looked up she had gone. In his hand was a shilling.

MARKSMAN.

Some General Remarks on Mechanised Foundries and the Making of Motor Cylinders*

By G. W. BROWN†

This subject is a very live one, and has already been fairly well discussed from different views, but it is believed that there is much yet to be said, and particularly by the user. The plant and methods which are the subject matter of this Paper are as perhaps it is understood at the Austin Motor Company's works at Longbridge,

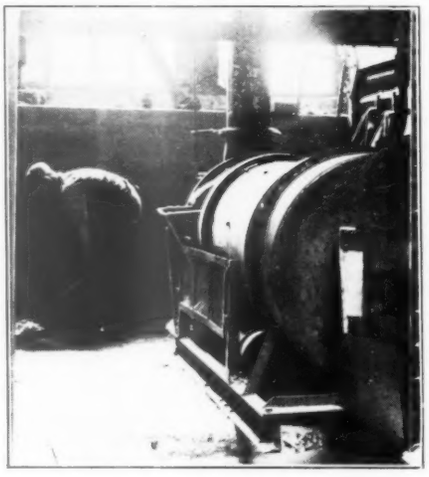

FIG. 1.—ROTARY SAND DRIER OF 2½ TO 3 TONS PER HOUR CAPACITY.

and it is also generally known that the company has spent and is still spending considerable sums of money to accomplish the results desired, and it is very gratifying that they so willingly allow this material to be used for this Paper.

It is not intended to deal with the methods of moulding—as each foundry has to determine these according to their detail of manufacture—or to dwell on the metallurgical side, as this again varies with the detail of manufacture, but

FIG. 2.—SHOWING SIDE-BENCH SUPPLY OF SAND FOR USE WITH MOULDING MACHINE.

to give a general survey of ways and means and furnish material on which a discussion can be built. The mass, or production in large quantities of many varying details, has brought about the demand for methods whereby these can be handled more satisfactorily, and the more the mechanical engineer studies these requirements the more easily will the foundryman be able to furnish the results required.

Foundry work consists of a large number of details, each in its turn embodying an exasperating variability whether it be cast iron, steel, or non-ferrous, but the mechanical means and what it stands for can reduce these to a considerable degree. The general conception of a mechanised foundry is that of a foundry as a mass of moving tracks, conveyors, belts, jigging screens, runways, and a conglomeration of mechanical details too numerous to absorb in a casual visit. A mechanised foundry, however, is the necessary, although belated, development, and a vital need, and the more help the foundries give to the makers of foundry equipment the quicker mechanical development will be and the better the plant. The term is very elastic, and the simple roller conveyor for the moving of castings is a step in the direction, and part of the general scheme.

The demands of the production engineers for volume, with a high standard, at a lower price will force the development into a prominent place in the general schemes which constantly occur in the lay-outs for production. The mere fact of mechanising a foundry will not give results unless it is accompanied by the control essential. The foundryman's attitude of rough and cheap equipment must change, and the ideas of putting the core-making in any old corner and under indifferent conditions will not have any place in the foundry of the future. Operations, as is common in the machine shop, will have to be split up and specialised.

The mechanised foundry is not replacing the skill of the foundryman; it requires greater skill and demands that it shall be applied at the proper place and at the proper time. The skill, however, must be in the visualising and in the laying out of the methods of production; in the equipment and supervision; in the close inspection of raw material; in the control of the metal melting and pouring; in the preparation of sand, and in the spirit of determination to reduce the variables to a minimum.

General Lay-out

The raw materials used in a grey-iron foundry are not easily or cheaply handled under any method, but they can be considerably reduced in cost by efficient and suitable methods. Pig-iron, scrap, coke, sand and limestone are details required in large bulk and are received in large lorries or railway trucks. One company built an inclined roadway from the main road to their cupola platform and all material was unloaded at the same level as the cupola charging door, which eliminated at least two handlings.

The most common lay-outs, however, lend themselves to lifting the material. In the case of the pig-iron and scrap, a lifting magnet is desirable, and with the coke, sand and limestone, a bucket grab is a very quick method, but has one defect in so far as coke is concerned, and this method tends to break up the coke by the grabbing action and also in the releasing, and quite a reasonable amount is lost as breeze and dust.

It is also advisable that the necessary tests are made on these materials before being unloaded if delivered by rail to the foundry siding, so that they can be returned if necessary or held separate until some arrangement is made with the suppliers. The storage and handling of these materials will be influenced by the space available, and also by the type of melting unit, whether cupola or rotary furnace. In the case of the cupola, the material will require to be taken to the height of the charging door, while in the latter it will not be necessary to elevate it except to lift it for charging.

The raw materials should be near to their point of entering production, and further mention will be made of this as the different sections are dealt with.

Core-making Section

In some details, particularly in motor-cylinder manufacture, this might be termed the pivot on which results swing, whilst in other classes of manufacture it will play a very secondary part regarding the lay-out, but will demand equal departmental results. The core sand should be stored under cover where it is easily accessible, and the floor should drain away from the

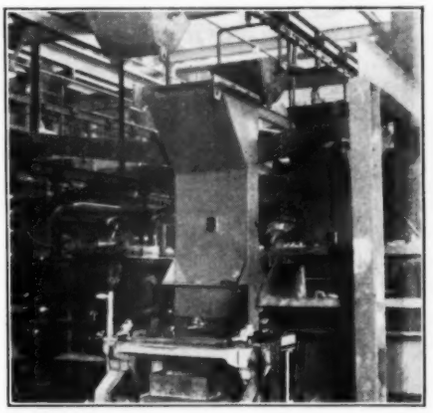

FIG. 3.—SHOWING HOW COREMAKERS' HOPPERS ARE SUPPLIED BY OVERHEAD BUCKET LINE.

place where supplies are drawn. Probably two or three different sands will be used, and these should be stored so that no complications arise through mixing the various types.

A large portion, if not all, of the sand will require to be dried, and this can be efficiently done in a simple rotary drier such as is shown in Fig. 1, the capacity of which is about 2½ to 3 tons per hr. The sand empties at a temperature of about 120 to 150 deg. C. Ample hopper, or floor-space capacity should be allowed for the sand to cool, and there is an opening for an

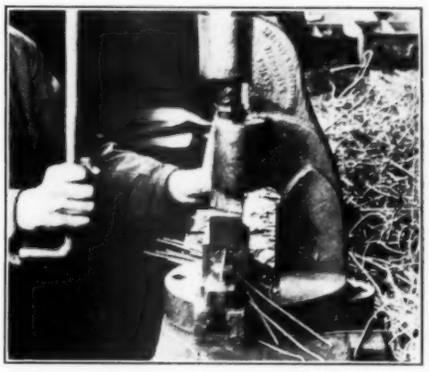

FIG. 4.—SMALL CORE-WIRE-STRAIGHTENING MACHINE ENGAGED ON RECLAMATION.

effective sand-cooling arrangement, as sand will not cool very quickly stored in a hopper, and there appears to be only two conditions of sand, either cool and wet or dry and very hot as it comes out of the dryer. This can readily be understood when one realises that dry sand is split up immediately into particles and that it is a very delicate job to dry so small a particle as a sand grain without getting it very hot.

D

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. A. S. Beech presiding.

† The Author is on the staff of the Austin Motor Car Company.

The mixing machines should be near the dryer, and so save unnecessary handling and transport. These machines, speaking in a general way, are not designed sufficiently robust for their work, and it is perhaps due to the desire to keep them at a price acceptable to the general ideas of expenditure on foundry plant. There are, however, exceptions to the rule, and the tendency is one of improvement.

The supplying of the mixed sand to the operators is a very vexed one, and must be controlled by the volume required and the class of details made. Many lay-outs can be given, but in large-quantity production the chief object should be to save the operators' time.

It is common in modern lay-outs to mix on a balcony and feed the sand down shutes on to a table round which the operators work, and the sand is within arm's length. Another method is to take the sand and put it into bins near the operators; each operator may have a hopper attached to the bench and the supply is maintained, as shown in Fig. 2.

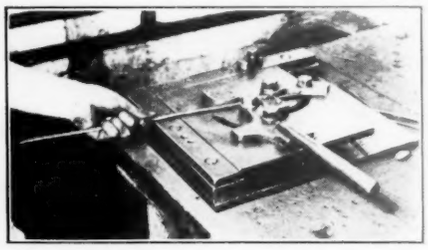

Fig. 5.—Bending Jig for Core Wires.

A further method in use is to take the sand round the core shop in an overhead conveyor, in tip-up buckets, so that the operator has simply to tip the bucket as it passes, and, when different mixtures are in use, the buckets are painted different colours. This is shown in Fig. 3.

The author's perspective will of necessity be largely controlled by the requirements of a plant dealing with cylinder castings, and the core shop of such a plant requires far more detailed consideration than is common in most details. For instance, in this particular shop, about 52,000 core wires are used daily, and this requires a section with the plant for preparing the wires ready for use and also, the organisation for reclaiming wires which pay to use over again. An automatic cutting-off machine is kept in constant use, the heavier wires being cropped off under a power press. Reclaimed wires are straightened on the power machine, and also by the hand presses shown in Fig. 4, the latter being a simple, yet efficient, method. Simple bending jigs, which are shown in Fig. 5, are made for each particular wire, so that the coremaker is kept supplied with wires ready for putting in position. Grids have also to be developed, made, and reclaimed after use.

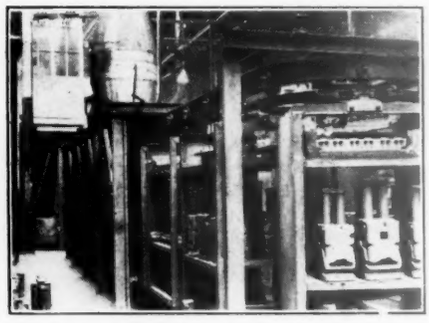

Fig. 8.—Continuous Horizontal Type of Core Stove.

Quantity production coreboxes are of metal and these are daily checked and kept to size, and duplicate sets are ready for replacing when the boxes are worn. Large and deep draw boxes are put on simple turnover machines fitted with vibrators (Fig. 2), while the small and shallow draw boxes are made on the bench. Quite a large number of cores are of such a shape that dryers are necessary, and these require constant attention for keeping to shape and cleaning off the dried oil and sand. A de-greasing plant is being installed, and it is possible that this is an entirely new departure in foundry practice.

Fig. 7.—Cores for Automobile Work being Ground to Size.

Too much stress cannot be given to the design and upkeep of all coreboxes and dryers for cylinder making, where such vital items as thicknesses of cylinder bores are so very vital. In cylinder making, the finishing, gauging and assembly of the cores play a very important part, and the expenditure of gauges and tackle is well repaid. These are shown in Fig. 6. "Go" and "Not Go" gauges are used when necessary, the same as in a machine shop, and grinding machines and rubbing jigs (Fig. 7) are used on parts where they fit in assembly.

When finish is important, the cores are blacked either by spraying or dipping, after which they are again dried either in a continuous oven or an inclined roller conveyor, or in separate ovens.

Fig. 9.—Loading a Continuous Core-Drying Stove.

The horizontal stove (shown in Fig. 8) travels at $1\frac{3}{4}$ ft. per min., the drying chamber is 38 ft. long and the cooling chamber 19 ft. long. The part and purpose of each separate core, of course, determines its operations, and each, again, is subject to experiments and development.

Core Drying

Indifferent drying of cores can cause endless trouble and nothing is more annoying than to find faulty castings due to cores either over or insufficiently dried. The type of core stove required will depend on the volume and details made—methods of taking to and away from the stoves, or, in other words, the lay-out of the core shop. Stoves can be oil-, gas-, or coke-fired, and makers' claims differ in their application. The stoves can be put under two types, fixed and continuous, while the latter can be either vertical or horizontal.

The fixed type are usually fed with portable racks which are filled near to the operators and either lifted bodily by an overhead crane and placed on rails leading into the ovens, or lifted by a lifting truck, either electric or hand operated, and taken direct into the ovens. A lengthy experience has shown that cores cannot be equally dried in this type, as it is usual for the inlet flues to be on the floor at the side, and the natural, induced, or forced flow of the heat cannot be equal throughout the area occupied by the cores, and therefore discretion has to be applied in the loading of the racks so that the larger cores will be placed where they will get the most heat and the smaller cores the least.

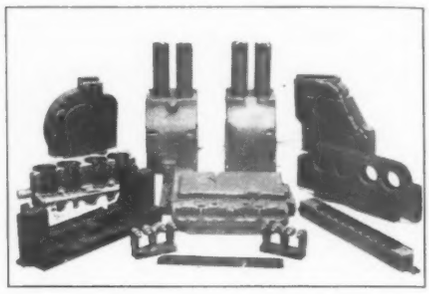

Fig. 6.—Set of Gauges used in Cylinder Making.

In the continuous type, different conditions prevail, and the core is subject to a rising and falling temperature, *i.e.*, as it enters and leaves, and the oven can be made large enough to subject the cores to a cooling system whereby they can be handled immediately they leave the oven, and, in addition, most of the fumes have been dispersed, making the conditions of the shop much more congenial. It would appear that the continuous vertical type has much to commend it over the horizontal type, chief of which is the smaller floor space required and the simple means whereby the cores can be subjected to the rising heat which appears to indicate a more economical drying. Such a stove is shown in Fig. 9. The number of cores dried per day is about 17,000, with a total weight of 25 to 30 tons, the individual weight ranging from 2 ozs. to 48 lbs.

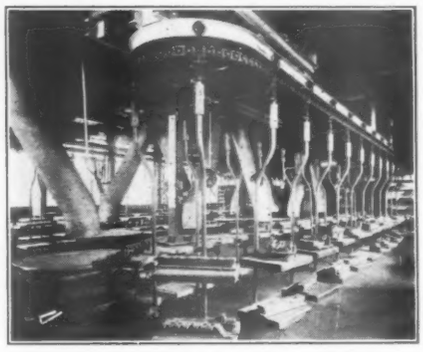

Fig. 10.—Pendulum Type of Conveyor Serving Core Stoves.

In the lay-out for the continuous type, a belt or pendulum conveyor is usually employed for taking the cores to and from the ovens. This

(*Continued on page* 198.)

Unsoundness in Aluminium Sand Castings*

SOLIDIFICATION IN SAND MOULDS UNDER PRESSURE

By Professor D. HANSON,† D.Sc., and I. G. SLATER,‡ M.Sc., Ph.D.

This Paper describes further stages of an investigation carried out for the British Non-Ferrous Metals Research Association on unsoundness in castings and ingots of aluminium and its alloys. The work now described concerns experiments in which aluminium alloy melts cast into sand moulds were allowed to solidify under an extraneous pressure of air or nitrogen. It was discovered that complete elimination of pinholes could be attained by suitable adjustment of the experimental conditions, a result considered to be of great interest from both theoretical and practical aspects.

Apart from a brief mention by Budgen[1] that gassy aluminium alloys, when allowed to solidify under considerable pressure, are remarkably free from pinholes, no previous work on similar lines had been carried out in so far as the authors were able to ascertain at the time of the commencement of these experiments (September, 1931). The principle of casting metals under pressure has been known for many years, and forms a very important branch of metallurgical engineering. In this process, the melt is forced under pressure into a metal die, where rapid solidification ensues. Pinholes, which are due to the presence of dissolved gases in the melt, are not usually evident in such castings, because of the rapid rate of solidification. The possibility of influencing the mechanism of the formation of pinholes in sand castings by the application of an external gaseous pressure appeared to be worthy of investigation, and the results obtained in some experiments carried out on these lines are described in the Paper.

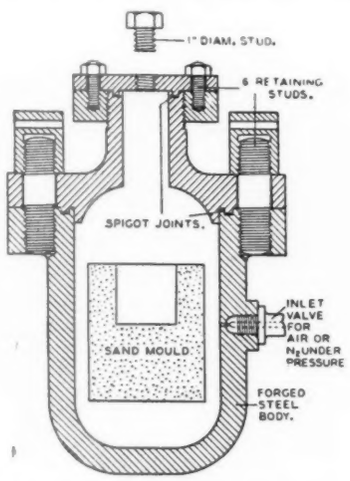

FIG. 1.—ARRANGEMENT OF AUTOCLAVE FOR THE SOLIDIFICATION OF ALUMINIUM ALLOYS UNDER PRESSURE IN SAND ALLOYS.

Experimental Methods Employed

The aluminium-alloy melt to be treated was poured into a skin-dried green-sand mould contained in an autoclave, which was immediately closed up, and a gaseous pressure of air or nitrogen applied so that the metal cooled and finally solidified under pressure. The autoclave used (see Fig. 1) was fitted with an arrangement for rapidly securing the pouring inlet and applying the pressure. The experimental procedure was as follows:—

The skin-dried green-sand mould was placed in position in the autoclave and the cover bolted down. A quantity of stock alloy was melted in an electric furnace and the temperature increased to 750 deg. C. When ready, the melt was poured via a funnel through the inlet into the mould. The pouring inlet was then quickly secured, and the predetermined pressure of gas turned on from a storage cylinder fitted with a reduction valve. This operation, from the finish of pouring to the application of the pressure, took not more than 20 sec. The smallest ingot cast (2 in. by 2 in. dia.) took 1½-2 min. to solidify, so that the pressure was applied in ample time before solidification commenced. Subsequently, the ingot produced was sectioned, polished and etched for visual examination of pinholes. This was supplemented by density determinations. The black-and-white illustrations given in Figs. 3 to 8 are reproduced from ink contact prints taken from the ingots.

Experimental Results

For the preliminary experiments, two batches of gassy stock "3L11" alloy (8 per cent. copper-aluminium) were taken. Each batch was of uniform composition and gas content, the second batch having been made very gassy by melting and stewing some of the first batch at 800 deg. C. Table I gives details of the results obtained with these materials when cast into a 2-in. by 2-in. dia. sand mould and allowed to solidify under a pressure of nitrogen. Sections of ingots Nos. 346, 350 and 362 are illustrated in Figs. 3, 4 and 5.

By allowing the alloy to solidify under pressure, an ingot having an increased density and visually showing greater soundness may be obtained. A pressure of 50 lbs. per sq. in. was found to be sufficient to remove all visible traces of pinholes from the 2-in. ingot. As might be anticipated, a somewhat greater pressure is required for the very gassy alloy, but at the higher pressures the densities are much the same for the two batches. The two tests at 700 lbs. per sq. in. were made to determine whether the curve correlating pressure and density became asymptotic. Little increase in density is apparent above a pressure of 200 lbs. per sq. in.

TABLE I.

Pressure. Lbs. per sq. in.	Stock "3L11" alloy.			Gassy "3L11" alloy.		
	Ingot no.	Density.	Appearance, pinholes.	Ingot no.	Density.	Appearance, pinholes.
Atm. ..	341	2.780	Moderately bad	346	2.749	Bad.
15 ..	352	2.812	Few	351	2.772	Moderately bad.
25 ..	345	2.816	Very few	350	2.802	Few.
50 ..	344	2.835	Sound	349	2.821	Sound.
100 ..	343	2.844	Sound	348	2.844	Sound.
200 ..	342	2.851	Sound	247	2.856	Sound.
700 ..	361	2.862	Sound	362	2.858	Sound.

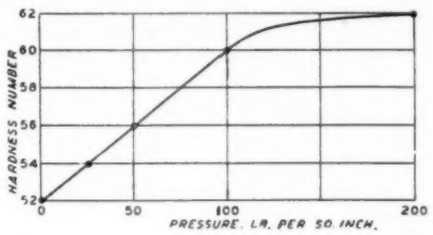

FIG. 2.—EFFECT OF PRESSURE APPLIED DURING SOLIDIFICATION ON THE HARDNESS OF "3L11" ALLOY CAST INTO A SAND MOULD 2 IN. BY 2 IN. IN DIA.

For comparison, ingots were prepared from the stock "3L11" alloy, after various degassing treatments had been applied to the melts, by casting in chill and sand moulds of various sizes. Particulars of these ingots are given in Table II.

Thus, by solidification under pressure, a sand-cast ingot may be produced having a density appreciably greater than that obtainable from ingots cast under atmospheric pressure in sand moulds from melts treated by any of the above degassing processes. It is probable that the density of 2.862 nearly approaches the theoretical optimum for this alloy when sand-cast. The actual analysis of this alloy was copper 8.15, silicon 0.35, iron 0.47 per cent., aluminium remainder.

TABLE II.

Stock "3L11" alloy: treatment and casting conditions.	Density.
None—cast in iron chill, 2½ in. dia.	2.809
,, ,, ,, 1 in. ,, ...	2.844
,, ,, ,, ½ in. ,, ...	2.871
,, ,, sand mould, 3 in. ,, ...	2.765
,, ,, ,, 2 in. ,, ...	2.780
,, ,, ,, 1 in. ,, ...	2.803
,, ,, ,, ½ in. ,, ...	2.830
Degassed by presolidification and cast in sand mould, 3 in. dia.	2.830
,, repeated melting and solidification *in vacuo* and cast in sand mould, 3 in. dia. ..	2.841
,, nitrogen treatment and cast in sand mould, 3 in. dia.	2.814
,, nitrogen + chlorine treatment and cast in sand mould, 3 in. dia.	2.830
,, nitrogen + bromine treatment and cast in sand mould, 3 in. dia.	2.834
,, titanium tetrachloride treatment and cast in sand mould, 3 in. dia.	2.821
None—solidified under 700 lbs. per sq. in. pressure and cast in sand mould, 2 in. dia. ..	2.862

A number of other alloys of aluminium which contained a moderate amount of gas were cast by the method of solidification under pressure in a 3-in. by 3-in. dia. sand mould, and the results obtained are collected in Table III. Sections of ingots Nos. 443, 447 and 455 are illustrated in Figs. 6, 7 and 8.

By the application of a gaseous pressure during solidification, all the alloys examined improved in density and soundness. With those alloys which show a more marked tendency to form internal shrinkage cavities, such as the

* Paper read before the Institute of Metals.
† Professor of Metallurgy, Birmingham University.
‡ Research Investigator, British Non-Ferrous Metals Research Association, London.
[1] N. F. Budgen, "J. Inst. Metals," 1929, **42**, 129.

eutectic silicon-aluminium alloy and the eutectic nickel-aluminium alloy, the increase in size of this cavity with increase in pressure is to be noted. This is clearly shown in the illustrations of ingots Nos. 443, 447 and 455. The density of the 6 per cent. nickel-aluminium series was determined with the internal shrinkage cavity closed and with the cavity open, so that the volume of the shrinkage cavity apart from the volume occupied by the pinholes could be ascertained. With the shrinkage cavity closed, the density remained practically constant for all pressures on solidification. This indicates that the total volume occupied by both the shrinkage cavity and the pinholes is constant, so that an interchange in the respective volumes occupied by the shrinkage cavity and the pinholes has taken place as the pressure is varied. The densities given in Table III were obtained after the specimens had been boiled in water prior to the weighing in water determination. In this manner, all cavities connected with the exposed surfaces are filled with water. In some cases, particularly with the "Y" alloy, small cavities due to shrinkage were found isolated from the main cavity, so that the observed density is in consequence rather lower than the true density of the sounder portions of the ingot.

Fig. 3.—Ingot 346 ("3L11"). Solidified under Atmospheric Pressure.

Fig. 5.—Ingot 362 ("3L11"). Solidified under 700 lbs. per sq. in. Pressure.

Fig. 7.—Ingot 447 (12 per cent. Si). Solidified under 50 lbs. per sq. in. Pressure.

Table III.

Alloy.	Ingot no.	Pressure during solidification.	Density.
"2L5" ..	441	Atmospheric ..	2.819
	457	25 lbs. per sq. in.	2.830
	445	50 " "	2.840
	449	100 " "	2.860
	453	200 " "	2.866
"Y" ..	442	Atmospheric ..	2.701
	458	25 lbs. per sq. in.	2.710
	446	50 " "	2.720
	450	100 " "	2.729
	454	200 " "	2.735
12 per cent. Si-Al	443	Atmospheric ..	2.602
	459	25 lbs. per sq. in.	2.624
	447	50 " "	2.644
	451	100 " "	2.646
	455	200 " "	2.654
6 per cent. Ni-Al	469	Atmospheric ..	2.748
	479	25 lbs. per sq. in.	2.750
	478	50 " "	2.773
	476	100 " "	2.777
	477	200 " "	2.786

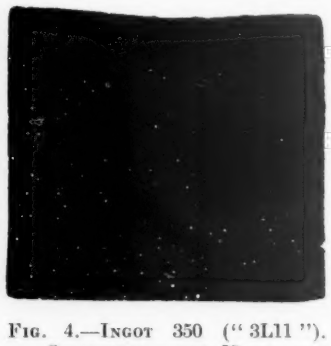

Fig. 4.—Ingot 350 ("3L11"). Solidified under 25 lbs. per sq. in. Pressure.

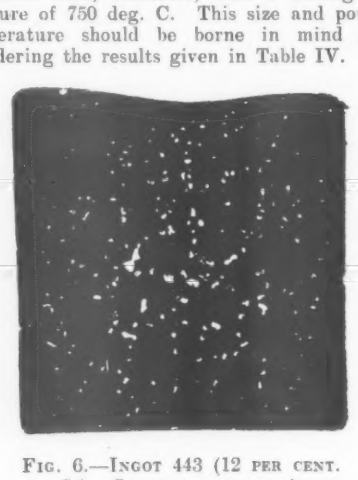

Fig. 6.—Ingot 443 (12 per cent. Si). Solidified under Atmospheric Pressure.

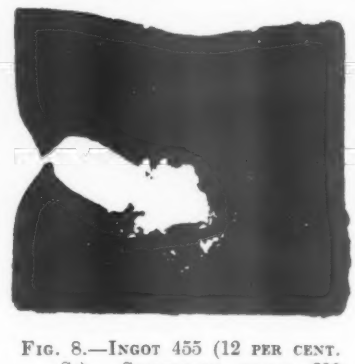

Fig. 8.—Ingot 455 (12 per cent. Si). Solidified under 200 lbs. per sq. in. Pressure.

Mechanical Tests on Sand-Cast Bars Solidified under Pressure

Hardness tests were carried out on the ingots described in Table I. It was found necessary to use a Brinell ball of 10-mm. dia. with a load of 500 kg. applied for 30 sec. Smaller indenters, such as the Vickers Diamond Pyramid, gave erratic results, especially with the less sound ingots due to the pinholes present. The Brinell hardness value increased from 52 to 62, according to the soundness of the ingot, which depends on the pressure applied during solidification. Actual values obtained are shown in Fig. 2. This increase in hardness appears to be due to the greater soundness of the pressure-cast ingots, since no material difference could be detected in the metallographical features of the various ingots.

Some sand-cast tensile test-bars of various alloys were prepared by solidification under pressure. The standard 1-in. dia. bars proved impracticable to make, since experiment showed that, on casting from 750 deg. C., this size completely solidified in less than 30 sec.—an insufficient time in which to carry out all necessary operations on the autoclave after pouring and to ensure that the pressure operated whilst the whole of the ingot was liquid. Bars of 1½-in. dia. were used, therefore, with a casting temperature of 750 deg. C. This size and pouring temperature should be borne in mind when considering the results given in Table IV. Considerable difficulty was encountered in casting perfectly sound bars, due to the entrapping of dross and oxide caused by the turbulent conditions of pouring. This could not be avoided, since, with the autoclave used, there was a perpendicular drop of 12 in. between the teeming funnel and the top of the mould. By using a central runner feeding, at the bottom, two test-bars, more satisfactory results were obtained, and in Table IV are given the results of tensile tests made on some of the sounder bars. The bars were turned to standard British Standards Institution dimensions of 0.564-in. dia. on a test length of 2 in.

A marked improvement was shown in the ultimate strength for both alloys when solidified under pressure. With the "Y" alloy, the percentage elongation was also substantially increased.

Table IV.

Material.	Pressure during solidification.	Ultimate strength. Tons per sq. in.	Elongation on 2 in. Per cent.
"3L11" (as-cast)	Atmospheric ..	6.4	2
		5.84	2
	50 lbs. per sq. in.	7.48	2
		7.72	2
	200 " "	8.76	2
		10.92	2
"Y" (as-cast)	Atmospheric ..	8.96	1
		9.2	1
	50 lbs. per sq. in.	11.6	1.5
	100 " "	11.84	2.5
	200 " "	11.6	2.5
		12.6	2.5

Effect of Heating "3 L11" Ingots Solidified under Pressure at Temperatures Above and Below the Solidus

In order to throw some light on the mechanism whereby the formation of pinholes is suppressed by the application of pressure during solidification, the following experiments were carried out. Rectangular blocks of about 10-grm. weight were cut from ingot No. 361, which was the moderately gassy "3L11" alloy solidified under a pressure of 700 lbs. per sq. in. The specimens were polished, and, after the treatments

(*Concluded on page* 189.)

The Metal Spraying of Cores and Castings*

By A. ROGER

The title of this subject does not convey anything to the average individual, nor is it possible for us to approach a real meaning without first studying the various processes, which have in the past been practised, and which now bring us to a commercial method of protecting various metals from oxidisation. About 50 years ago a crude attempt was made in Germany to coat metal by spraying under pressure actual molten metal in a crucible, and forced by steam pressure through a nozzle on to the object to be coated.

In 1893 a method was patented in Switzerland in which a stream of molten metal impinged a rapidly-rotating paddle wheel and projected against the cold wall of a container very fine pellets of metal which were afterwards projected from a nozzle through a flame which heated these pellets, and which were again solidified on hitting the object to be coated. There was about this time many methods of projecting pulverised metal through a flame and depositing a molten or semi-molten coating on the object to be sprayed, and it was through these experiments that we learn that the projection velocity must not exceed a certain limit.

It was necessary with the afore-mentioned methods to operate with pressures of nearly a hundred atmospheres, and it was found that though a protective coating could be made, the loss of metal through rebound prevented this from becoming a commercial proposition.

To-day the metal-spraying pistol operates with a pressure of not more than three to four atmospheres, and the loss of metal is comparatively small, on surfaces of but a few square inches, whereas metal powders and metal in its molten state were utilised; the present arrangement utilises a feed metal of any composition which can be drawn into wire.

If a metallic wire be fed into a blow-pipe flame, and providing that the flame be hot enough, the wire will be melted as it passes into the hot flame, and if the drops of fluid metal so formed are met by a stream of gas travelling at high velocity, then the drops will disintegrate into fine particles and form a spray. The flame must necessarily be hot enough to melt the wire, and the flame must be strong enough not to be disturbed by the velocity of the gas. Such a flame can be obtained if a combustible gas under sufficient pressure is mixed with oxygen under pressure, and burned from a fine jet. In the pistol, the mixture of gas and oxygen issues from small ports arranged as a ring, and in the centre of the ring of ports is a hole which serves as an entrance for the wire.

The combustible gas can be anything of reasonable calorific value, the gases in common use being coal gas, hydrogen and acetylene used at pressures of 10 to 30 lbs. per sq. in. An admixture of oxygen at a similar pressure is arranged for in a mixing chamber immediately behind the nozzle. Any gas such as nitrogen, hydrogen, steam, etc., could be used as a spraying blast, but it is obvious that compressed air is more easily obtained, and it is therefore used commercially, being forced to encase the flame by issuing from an annular orifice surrounding the gas ports. The pressure of air varies with circumstances from 35 lbs. to 80 lbs. per sq. in. In this country 45 lbs. per sq. in. can be taken as an average. The volume of the gases used varies greatly with the metal to be sprayed, but average figures are: air 15 cub. ft. per min., gas 70 cub. ft. per hr. and oxygen 35 cub. ft. per hr.

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. A. S. Beech presiding.

The first personal experience of the wire pistol was an assembly of Werner Schoop, son of Dr. Schoop, the inventor of the "Wire Spraying" process which differs from that of the English pistol by virtue of the unique method of propelling the wire through the projecting nozzle. In this case the gearing was driven by a pelton wheel, rotating at 4,000 to 5,000 r.p.m., and driving a screw-cutting type of wire feed, which replaced the usual high-speed air turbines and the triple-reduction gear. It had the advantage of being variable within certain limits by altering the inclination of the pressure wheels to the axis of the wire.

The turbine was driven by air, by-passed from the air feed to the nozzle, as is the present pistol, which has a reducing gear driven by a magnesium-alloy turbine, 2½-in. dia., at a speed of 1,200 to 3,000 r.p.m., and drives two rollers which grip the wire and propel it through the nozzle. This pistol weighs 3½ lbs., and has taken the place of the Werner Schoop pistol, which, though lighter in construction, was less efficient owing to the higher velocity of the pelton wheel.

Other Types of Pistols

A commercial process which should be mentioned here, and one which takes one back to early days of spraying, and used very effectively in America, is the "Gravitas gun," chiefly employed where large flat areas are to be coated. This arrangement utilises metal in powder form. On account of the metals being already finally divided, a greater quantity can be heated to a plastic state in a given time by the flame, and added advantages are, that less gas and lower air pressure are required to impact them, and the possibility of carrying the metallic dust from the container to the muzzle of the torch by air pressure eliminates all gearing or other mechanism from the "Gravitas gun." This apparatus uses either acetylene or hydrogen and oxygen in combustion with compressed air.

The "Gravitas" consists of a cylindrical container, which holds about 20 lbs. of powdered metal. At the top is fitted a removable cover, to which is attached a pressure gauge, and at the bottom of the container is placed an ingeniously constructed gas-dust distributor. From the distributor the metal dust passes through a rubber tube to the spraying tool or "gun," which, by an ingenious construction, passes it between two concentric flame zones at the muzzle, where it is instantly heated to a plastic state, and impacted on the surface to be coated. The drawback to the "Gravitas" principle is that powder is difficult to obtain in commercial quantities.

Again there is at present being operated in the north a novel form of pistol which, as yet, has not obtained general application, and which may be termed for the want of a better name the "oxy-electric" gun. This is capable of spraying metal of such material as cannot be drawn into wire form, such as cast iron. The operation of such is the melting of the spraying materials by electric arc or the mixing of two variable metals by arcing and projected as a coating on to the object by air under pressure. This process is very simple, but much slower than the previously-mentioned methods.

Surface Preparation

In all the methods it is essential for successful metal spraying to prepare the surface to give adhesion to the metal coating, with the exception of porous surfaces such as cardboard, plaster, and the like, as the texture and adhesion of the sprayed metal is primarily due to the interlocking of the particles, which depends on a form of mechanical keying to the surfaces, and therefore the latter must be roughened so that the meshwork of the surfaces conforms approximately to the size of the particles to be received. This is done by sand-blasting with flint sand, and usually of 20-mesh grade. It is essential that the sand must be dry, and blasting should be done immediately before spraying. The work must be kept clean and free from grease until the spraying is completed. For most purposes a $\frac{5}{16}$-in. nozzle will be found suitable, using about 100 cub. ft. of air per min. On straightforward work 35 to 40 sq. ft. per hr. can be expected from one man. There are, of course, many types of automatic sand-blasting machines which can be applied to special requirements. The necessity of having to use sand-blasting is probably the one and only reason why this process of treating metals has been delayed, but now it is quite common to find sand-blasting apparatus even in small foundries, and very little knowledge other than foundry sand-blasting is required to carry out this work efficiently.

To the engineer and to the foundryman the "Schoop Pistol" has gained an honourable name, very appropriate to its purpose, and that is the "putting-on tool." The wire with which it is fed is usually 1 millimetre diameter, but for tin and lead it is 1.5 millimetre. It is melted in a blowpipe flame, which is fed with oxygen and a combustible gas, both of which are used at pressures varying up to 30 lbs. per sq. in. The oxygen is usually obtained from commercial cylinders such as are commonly used for welding or cutting, and it is necessary that the regulator be fitted with a high-pressure gauge for measuring the contents of the cylinder and a low-pressure gauge to check the pistol working. The combustible gas may be hydrogen, coal gas, acetylene, or in fact any gas of sufficient calorific power. Hydrogen is usually obtained from cylinders. Acetylene, if used, must be in the form known as dissolved acetylene in cylinders, and it is important to note that this gas cannot be taken from low-pressure acetylene generators. Coal gas must be used from cylinders which must not be stored too long as compressed coal gas deteriorates, or, as is more usual, compressed to 25 to 30 lbs. per sq. in. on site by means of a small compressor, the gas being drawn from the town main through a non-return valve.

The wire enters the blowpipe flame, and is surrounded by compressed air fed through the annular nozzle. The air itself, at a pressure from 35 to 50 lbs. per sq. in., in contact with the hot expanding gases of the flame causes high pressure at the melting focus, and forces the molten metal forward as a fine spray. The velocity of this spray is estimated to be about 760 m.p.h. The particles encountering any obstacle, the surface of which has been suitably prepared, will adhere with high tenacity as a film.

Filling Defects in Castings

The heat generated by the flame is so dissipated by the air that at spraying distance—that is, about 5 in.—the spray is only slightly warm. This is important, because it is on account of the low temperature of the spray that the metal coating of inflammable articles and metals which are likely to be damaged by high temperature, such as spring steels, can be successfully accomplished. The actual spray is cold. The process of metallisation is spoken of as a means of preventing oxidation of metals. This is not all its qualifications.

Blowholes are still in the habit of coming up and ruining some of the foundrymen's most expensive handywork. This is where the "puting-on-tool" is of assistance, and cast-iron rolls have been sprayed with a heavy nickel coating, whilst the blowholes have been filled with nickel. Prior to this, however, they must first be reamered out, and under no circumstances should an attempt be made to fill a bottle-necked hole.

XUM

It is necessary to have the hole perfectly dry, and it is preferable to warm the spot prior to spraying.

Most foundries to-day are equipped with an air-line, and it is only necessary to carry the cylinders and pistol to the nearest point of outlet in this air-line to proceed with the work *in situ*. The blowholes in a fan runner have been filled up, prior to spraying of the whole surface. Bronze propeller blades are heated around the cavitated parts before spraying. Because this is neglected, condensed moisture may be imprisoned beneath the metal layer, and may lead to its destruction, in which case the metal would be liable to peel off. It is, of course, unnecessary to preheat work sprayed in the workshop, unless it is of unusual importance, or if it is known that condensation is likely to set up. When the operator actually sprays the blade, it is the equivalent of blowhole filling, and to all intents and purposes the making good of a scabby casting. After spraying, the work can be tooled up by any ordinary process, such as chiselling, filing, or grinding.

Nature of Coating

The surface of the sprayed metal is always matte unless it be subsequently polished. An objection has been raised to the use of sprayed metals on account of porosity, but by careful manipulation of air pressures it is quite possible to spray coatings of zinc, lead and tin that will be definitely non-porous to liquids. Personally, the author has experienced difficulty in obtaining a non-porous coating with aluminium, brass and copper, and the higher melting point metals by means of the pistol alone.

The speed of spraying, and the distance of the pistol from the work, influence the nature of the coating produced. It has been found possible to metal-spray a piece of metallic sodium with so non-porous a coating of lead and tin that no action occurred when the sprayed sodium was thrown into water. It has been found that heating the article to be sprayed has the effect of preventing porosity, and this can be accomplished in a very simple manner by encompassing the spraying nozzle with a number of blowpipe jets; also very good results have been obtained by precipitating within the pores of the metal an insoluble non-poisonous chemical compound. Similarly, one may bring about the formation of an insoluble chemical compound in the pores of the sprayed metal by means of a polymeric change in certain mixtures of organic chemicals.

Micro-Constitution of Sprayed Metal

The transverse microstructure of sprayed iron shows that spray particles vary considerably in size, but do not ever exceed in diameter one-hundredth of a millimetre. It is possible that they are spherical when formed, but their impact with the molecules of the atmosphere alters their shape, and although they are passing through a few inches on their journey at a speed of about 700 miles an hour or more, they are probably solid when they strike the surface to be coated. At the moment of the impact they most probably become semi-fluid or plastic, because each particle takes the form of a saucer with thick edges. It is fairly certain that the interval of time which elapses between the entrance of the wire into the flame and the striking of the particles into the surface is so short that oxidation does not take place during this period, but some oxidation takes place on the surface of the particles before it is covered with the next arrival.

When molten droplets of metal run together, as, for instance, in foundry casting, there is obtained on cooling a continuous mass of crystallites separated here and there by gas inclusions. The spraying process, on the other hand, is cold, and spray metal is composed of separate particles held together by mechanical locking, and perhaps to some extent by partial fusion at the moment of impact, giving a typical heap structure. One can imagine, then, that this heap structure will retain a little porosity. Owing to the fineness of the spray, and the velocity imparted to it by the modern tool, this porosity is now about equal to that of a cast metal of similar thickness. It follows that the lower melting point metal such as tin and zinc will give a finer spray, and therefore be more closely packed together than such metals as iron or nickel. Therefore, coatings of these latter metals will need to be thicker to give the same continuity of structure. It is necessary to understand that there is little oxidation during spraying. Magnesium wire can be sprayed without firing, and brass does not lose zinc to more than about 0.2 per cent.

Properties of Sprayed Metal

Each particle is lightly oxidised in the instant after deposition, so most coatings contain a little oxide, but not in the form sometimes found in castings as large inclusions, but in the form of tiny films usually invisible microscopically except in the case of the higher melting point metals; also X-ray analysis of these coatings has indicated that the particles are slightly work-hardened, and this, combined with the presence of these oxide films, gives to spray metal a total hardness slightly in excess of the hardness of the metal in the cast state. The strength of sprayed metal itself is approximately equal to that of a casting, although the specific gravity is a little lower. On annealing spray metals at a temperature sufficient to bring about recrystallisation, a slight contraction in volume is noted, and the structure becomes similar to that of ordinary fully-annealed metal. The electrical conductivity of sprayed metal is usually about 80 per cent. of the value obtained for metallic wire. The adhesion of the coating will vary a little with circumstances, but is usually from 5 to 7 tons per sq. in. straight pull, providing that sand-blasting has been effectively carried out, and that, as is essential, spraying is carried out within half an hour of the blasting. It is well known that numerous metals have the property of taking up hydrogen and other gases whilst in the molten state. This property is common to iron, and to a great extent to nickel, so-called "spitting" occurring by reason of the occluded gases being driven out on solidification. It is apparent that both the absorption of gases and also the "spitting" play a certain rôle in metal spraying, and may influence the solidity or porosity of the sprayed layer. A simple test of porosity of coatings on iron consists of wiping the sprayed-iron article with a solution of ammonium chloride, and if there are any pores the coating becomes covered with a visible amount of rust after standing for about 12 hrs.

As is known, chemically-pure metals are the least readily attacked, since the minute impurities in commercial varieties induce local electrolytic action which results in the rapid destruction of the metal. The ability of metals to resist corrosion is largely dependent upon their position in the electrochemical series, and two dissimilar metals in electrical contact placed in an aqueous solution give rise to an electric current, and that the generation of the current is accompanied by the dissolution of one of the metals. In the case of iron and zinc plates connected together and immersed in an electrolyte, such as salt water, the zinc always is attacked, and the iron is not corroded until all the zinc has suffered dissolution. By taking couples of the various metals it is possible to arrange them in an order known as the electrochemical series, which is generally gold, silver, copper, lead, tin, nickel, iron, zinc and aluminium. Always the less noble metal is sacrificed as a protection to the other. Iron coated by hot-galvanising process with zinc alloys is not so liable to rust in contact with ordinary water as is tin-wiped iron. The corrosion of metal in air occurs primarily through the influence of water vapour, carbon dioxide, H_2S and SO_2 gases.

Aluminium coatings are not to be recommended for rust protection unless of considerable thickness, because the iron dissolves in acidulated water and separates out on the surface as rust, thus discolouring the article.

Sprayed zinc coatings, unlike articles which have been galvanised, have been found to be excellent base for paint or varnish; paint adheres even firmer to the sprayed zinc coating than to the bare iron; in fact, an enamelled zinc coating has been used for several years as a protection to a well-known household wringer.

Let us now proceed to the more *practical applications*. There is evidence of the usefulness of this process combating corrosion, but there is a very much wider field to be explored. It has been shown that the heat of the metal spray is not great at a few inches from the pistol; so little, that inflammable celluloid can be sprayed without any risk of burning, also fine textures such as silk curtains, etc. During the last year or so experiments have been made on the filling of cracks, blowholes and the like, with a great amount of success. For filling up cavities in iron, brass, copper, and aluminium vessels, thick coatings of aluminium are very satisfactory. In an iron vessel with walls 4 mm. thick, five holes 4 mm. in diameter were drilled; these holes were then filled up by spraying with zinc, brass, copper, iron, and aluminium. The vessel was then put under water pressure, and it was observed that the holes filled up with iron and aluminium were completely water-tight at 25 atmospheres pressure. The remaining metals did not, however, become sufficiently solid to maintain this pressure even after hammering.

Most personal research has been in connection with the motor engineers foundry, and thus the examples will allude solely to this particular section. Cracked water jackets in cylinder blocks have been encountered by all many times to their sorrow. Numerous examples of this are being treated by this process every day, and has been found in every way equal to welding. Welding to the motor engineer is perhaps his greatest nightmare. No matter how carefully the work may be carried out distortion will occur, and endless machining ensues, and there is always the fear of an upset when the repaired part is put into commission again.

How many times have founders seen some of their best castings on the scrap heap through the breaking in of a riser. The "putting-on-tool" can level this up in a very short time, making a much better job than iron cement, and taking very little longer.

The building up of worn parts is quite within the category of the pistol. Errors in machinery are often rectified with this clever little "putting-on-tool." Worn pistons can be satisfactorily treated with a coating as thin as 0.002 of an inch.

A skilled operator can add but an extra even thousandth or so for grinding to a finish. Ring glands can be build up. Motor shafts for the underground railways have been built up on the journals with as much as $\frac{5}{8}$ in. of nickel. Brake-drum liners sprayed with copper externally, and machined to press limits, have been found to assist in heat dissipation very materially, and increase the life of the liner many times. Wood and metal patterns have been treated extensively, and it has been proved to be a great saving in moulders' time. The pattern can be polished to a very high finish, and will withstand rough usage, and definitely increase productive life. It is also possible to use the spraying process in the same manner as electrotyping, and to produce facsimilities of moulded articles.

Novel Patternmaking Method

The author has made several replicas of small articles by taking a plaster cast, and spraying the mould with a 2- or 3-mm. coating, afterwards filling the shell with plaster, and using this as a pattern, the whole operation not taking

more than half-an-hour, where a similar pattern made in wood may take the patternmaker probably two days.

During the war, when copper was scarce in Germany, the copper bonds were removed from certain electric railways, and electrical connection between the two rails was secured by sand-blasting the rail ends *in situ*, and spraying them with zinc. Inside surfaces of the fishplates were similarly treated.

The metal-spray process has also been used to cover cast-iron resistance grids, such as are used in connection with tramways and other motors. If such grids be zinced, the value of the composite resistance is not altered by the formation of corrosion products at the many joints.

Mould Spraying

Quite satisfactory results have accrued in the attempts made with the spraying of green-sand moulds with several different metals. It has been found a great salvation of scrap, where intricate castings, with varying thicknesses, which gave trouble through cracking due to uneven contraction, were sprayed with nickel, at such places where it was necessary to delay cooling, and to even out stresses.

Due to the use of hydrogen, progress was delayed for a considerable time, as it was found later that compressed hydrogen created unusual sweating, until one day by accident coal gas was used with success, and many of the troubles experienced in the past were abolished. It was considered that the effect of spraying merely acted as a chill, but it was later found that the iron actually absorbed the sprayed alloy.

The difficulty experienced then was to have such alloys as proved beneficial to the quality of the casting, prepared and drawn into wire, and to-day this difficulty still exists, but to a lesser degree. It is safe to say that the people who manufacture the wire for metal spraying would be pleased to give every possible assistance to any special requirements.

It is not proposed to enter too deeply into facts as personal research is still in the "confounding" stage. Insufficient has been done at the moment to enable the presentation of very definite figures, and to detail personal experiments at this stage may be misleading. It has been found, however, that by varying the thickness of spray metal in proportion to the thickness of metal surrounding this film, very definite hardness figures can be obtained similar to the chilling effect one obtained by varying the thickness of the chill. Zinc and aluminium are the chief metals used for this purpose; they are easy to spray and comparatively cheap.

Sprayed Cores

In the manufacture of automobile manifolds, where a very clean core is demanded, aluminium sprayed cores have been used with great success. Wiring has in many cases been eliminated, the spray film giving rigidity sufficient to eliminate this. After the casting is made a few taps are given with the hammer, and the core drops out, leaving a perfectly clean hole. One point must be emphasised here. Great care is necessary in venting the cores to free them from the gases given off by the metal film. An attempt was made to protect an iron pipe against internal corrosion by spraying the core with cadmium; although a coating of less than one millimetre was applied to the core, this pipe has shown no signs of attack from corrosion after five months' usage.

In conclusion, the author would like to thank Messrs. Metallisation, Limited, for the loan of lantern slides, and in particular Mr. W. E. Ballard for his co-operation and assistance in the preparation of this subject; also Messrs. the Burtonwood Motor Engineering Company, Limited, for their encouraging interest and willingness at all times to assist in the furthering of this object.

Unsoundness in Aluminium Sand Castings

(*Concluded from page* 186.)

as detailed in Table V, the density was determined and observations made on the previously-polished surfaces.

The solidus of this alloy is at 548 deg. C., and the liquidus at 630 deg. C.

The surface appearance of specimens 361C and 361E showed blisters. Blisters on specimen 361C stand up from the surface as definite excrescences, dendritic crystal forms being visible on their surface. Treatment at a temperature below the solidus produced a slight effect only with the specimen heated *in vacuo*. At temperatures above the solidus, portions of the specimen in the region of the eutectic constituent were liquid and free to move, and at the same time the mass had little rigidity. Thus the presence of gas in the metal manifested itself by accumulation and expansion at these areas in the form of gas-filled cavities.

Table V.

Specimen no.	Treatment.	Density.	Appearance of polished surface.
361	As solidified under 700 lbs. per sq. in. pressure	2.862	Bright and uniform.
361A	Heated to 500 deg. C. for 2 hrs. at atmospheric pressure	2.861	No change.
361B	Heated to 550 deg. C. for 1 hr. at atmospheric pressure	2.842	Eutectic had sweated out as blisters and eruptions
361C	Heated to 595 deg. C. for 10 min. at atmospheric pressure	2.829	Large blisters formed.
361D	Heated to 500 deg. C. for ¾ hr. at 3 mm. pressure	2.851	Little change.
361E	Heated to 595 deg. C. for 10 min. at 3 mm. pressure	2.800	Large deflated blisters formed.

That the total gas content of ingots solidified under pressure undergoes no change by this treatment is shown on remelting such ingots in an electric furnace and allowing to solidify in air. The ingots so obtained had a density similar to that of the original material.

DISCUSSION

Sieverts,[2] Röntgen and Braun,[3] Röntgen and Möller[4] have shown that hydrogen is not soluble in solid aluminium, and such of its alloys as have been examined. Thus, the effect of pressure on the solubility in the solid state will be negligible, whereas in the liquid state increase in pressure results in a proportional increase in solubility. It is evident that the dissolved gas (consisting mainly of hydrogen) is rejected from solution on solidification, and, in ingots solidified under pressure, the evolved gas is retained as a separate phase under pressure. The net effect of solidification under pressure appears, therefore, to be the squeezing up to smaller dimensions the pinholes, which normally would be formed. As solidification proceeds under these conditions, the period at which gas is evolved from still liquid metal is delayed, due to the increase in solubility resultant on the application of pressure. When finally the gas is evolved as the last portions of interdendritic material solidify, the applied pressure further operates in compressing their volume according to Boyle's Law. Moreover, the pressure applied ensures that interdendritic liquid is forced into regions where shrinkage cavities are liable to occur and thus completely feeds the ingot, apart from the main pipe cavity, providing that the pressure is high enough. This effect is shown particularly with the eutectic alloys cast at the higher pressures.

The immediate practical considerations which arise from these observations may be summarised as:—(*a*) A method for the production of aluminium-alloy castings, which may be produced from melts of indifferent quality as regards gas content, whereby the castings are free from pinholes. This effect will operate independently of the rate of cooling as determined by the material of the mould and the size of the casting. In addition, the castings will have enhanced physical and mechanical properties, and (*b*) a method for the production of castings which are free from isolated shrinkage cavities. It will be necessary to allow for the additional volume of metal required due to the increased total shrinkage. This is a matter of simple foundry technique in the provision of adequate feeding gates and in the design and lay-out of the mould, whereby solidification proceeds progressively and is finally completed in such feeding devices. This application is not only confined to sand castings but also to chill castings, in particular those intended for subsequent rolling. The principle will apply in addition to all metals and alloys as well as the aluminium alloys now discussed.

Discussion of the technique for applying to industrial practice the principles now described is a matter for the engineer. It would be uneconomical to use a method developed on the lines of the present experiments in which a single autoclave is used, except for particularly important castings. Certain engineering operations are conducted in enclosed spaces under pressure, such as in tunnelling, where air pressures up to 50 lbs. per sq. in. are often employed. The transference of the casting section of the foundry to a subterranean vault maintained at a suitable pressure is considered, therefore, not to be beyond the realms of possibility.

Summary

1. By allowing aluminium-alloy melts to solidify under pressure in sand moulds, ingots showing less unsoundness and of higher density may be obtained. A pressure of from 50 to 100 lbs. per sq. in. (dependent on the initial unsoundness of the metal) is sufficient to remove all visual traces of pinholes from a 3-in. by 3-in. dia. sand-cast ingot.

2. The densities of ingots cast at higher pressures are appreciably greater than those obtainable in ingots poured from melts treated by various degassing processes.

3. The tensile properties of sand-cast "3L11" and "Y"-alloy test-bars are considerably enhanced by solidification under pressure.

4. On heating pressure-solidified 3L11 alloy to temperatures between the solidus and the liquidus, the presence of gases retained in the ingot is shown by the appearance of blisters and cavities.

5. The net effect of solidification under pressure appears to be the squeezing up of the pinholes, which normally would be formed, to smaller dimensions. At the same time, the casting is more completely fed and shrinkage is confined to one local area.

6. The principles now discussed are probably applicable to all metals and alloys whether sand- or chill-cast.

Acknowledgments

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[2] A. Sieverts, "Z. Elektrochem," 1910, **16**, 707.
[3] P. Röntgen and H. Braun, "Metallwirtschaft," 1932, **11**, 459–463.
[4] P. Röntgen and F. Möller, "Metallwirtschaft," 1934, **13**, 81–83, 97–100.

XUM

The Costing Report

SCOTTISH FOUNDRYMEN'S DIVERGENT VIEWS

The January meeting of the Scottish Branch of the Institute of British Foundrymen, over which Mr. H. Hurst presided, was devoted to hearing and discussing the report of the Sub-Committee on Costing Methods, with special reference to melting costs.

MR. HURST said that he should draw their attention to the fact that, according to the Branch programme, Mr. Delport's name appeared and not Mr. Hodgson. Mr. Delport had been unable to be with them, but Mr. Hodgson had kindly undertaken the job.

MR. HODGSON, in introducing the report, said, by way of explanation, that the Costing Sub-Committee began their work some eighteen months ago, and during that period had given very careful consideration to methods of foundry costing. They hoped to be able to formulate methods by which all foundries could determine their costs. The report* had already been published in THE FOUNDRY TRADE JOURNAL some time ago, so as to allow everyone to read and study them before discussion took place. He would like to feel that all who were present at that meeting had studied the printed report.

The CHAIRMAN said that in a highly-mechanised foundry, where they cast the same metal all day long, the cost of the scrap was a simple matter, but in the case of the small jobbing foundry which represented a sort of "jack of all trades," it was not so simple, as every job was something different. In the case of an engineering-shop foundry, where it was usual to be told at the end of the year that the castings had cost so much and they could have been bought for 6d. per cwt. less outside, it would not be satisfactory to cost domestic scrap at the cost of pig-iron. His own view was that the cost of returned scrap should be ignored altogether. The first day a foundry starts with pig-iron and bought scrap, and then melts each day its return scrap. If one values the scrap at the cost of the mixture plus melting costs, one values it too highly. A jobbing foundry might have half-a-dozen different scrap costs each day, and if the manager is wise, he will segregate the scrap for each job and, when used, it brought them back to the standard mixture. He did not think it was possible in any foundry to get very accurate costs for scrap, and he advised that it be ignored.

MR. HODGSON said that he thought he might start by saying that it appeared that it would be as he anticipated, there was going to be two distinct sides, a few who would be on his side and some who would not. He knew that many foundry managers were inclined to take the view that it was his job to make the castings, and the cost-clerk's job to find out the cost and see that the auditors were satisfied and that his profits were correct. Many years ago a large number of foundries were run on those lines in all departments. The foundry manager simply looked at the fracture of the pig-iron, and made his mixtures by that. He had no analyses. To-day the foundry manager could not work in that manner; he wanted the analysis of the iron as well as fracture appearance, and also wanted to know how and where the pig-iron was made. In the foundry with which he was associated all the irons used were low-carbon and silicon irons made in the rotary pulverised-fuel-fired furnace, and they were compelled to consider the value of the returned scrap. At the end of the week he might have 15 tons of different varieties, perhaps 5 tons of gates and risers. That was not enough to supply the foundry, and they had to buy in scrap. What value should he put on his domestic scrap? Is it what it cost or what his bought scrap cost? The opinion of the majority of the committee was that it was not sufficient to take an average cost over 12 months. The value of the total production last year might not be the price this year. No one knows what the cost of No. 3 pig will be this year. The basis of 1934 may be entirely changed in 1935.

MR. MCARTHUR said that he did not agree with the committee's proposals for valuing scrap. He thought that any scrap produced was no concern of anyone but the particular foundry. Returned scrap was only of value to the particular shop. Overheads should not be charged on raw material, but only on the tonnage of finished castings produced.

MR. HODGSON: You mean scrap is a by-product of the cupola?

MR. MCARTHUR: No, of the foundry.

MR. HODGSON: So the cupola would sell it back to the foundry.

MR. BALLANTINE said that he knew of a foundry where the practice was to value the returned scrap at the cost of the pig-iron less 5 per cent.

Metallurgical Scrap

MR. R. LIDDLE said that he could not altogether accept the recommendation of the committee. In his case the scrap was often worth very much more than the cost of the original mixture. He had castings weighing 10 tons apiece returned, or very large heads which cost him 5s. 9d. per ton to break. What could be done in the case of 50 or 60 tons of heavy castings that were made and rejected before the machine shop had received them? He had that experience of making castings to special instructions of special metal with alloys added, and the analysis was altered before the first one was in the shop. The metal could only be used for further jobs of the same kind. From past experience, he considered it necessary to make allowance for fluctuations in prices, according to the alloys added. His contention was that in the case mentioned, the scrap could only be used at a high price. They could not blame the foundry, because they had produced the goods demanded by another department and rejected by the customer. It was really a case that the research side wanted to make the best possible job, and they made the metal much more valuable. The 5s. 6d. or 5s. 9d. per ton for breaking in this case brought the value up to an extra 16s. or 17s. per ton.

MR. HODGSON said that raised an interesting point; he himself had had a similar instance recently. The heavy lorries used to run on solid tyres, but they are now on pneumatic tyres. They had a large stock of about 100 tons of rims which could not be used. They were sent with a credit note at the current price. They cost 5s. per ton to cut up, and the machine shop had to pay for it. A parallel case was where fire-bars were asked for in cylinder metal and returned because they were too good. That was not in any ordinary sense a foundry return. If they had been supplied of too great a weight or wrong in size, that would be a foundry fault, and then there would be nothing for it to cut them up or sell them.

MR. LIDDLE said if he made five castings in two days and by the time the analyses were finished they were found to be of the wrong composition, he could not then ask the machine shop to cut them up because it would have been too expensive and there would be nothing for it but to break them under the tup.

MR. HODGSON said these were isolated cases and not a general state of affairs.

MR. LIDDLE said the first casting made was the cheapest because it cost 5s. 3d. to break the heads. The first casting had no head-breaking to pay for, but in the second, third, etc., there was the cost of breaking to be added.

MR. HODGSON said that applied to any special casting. For instance, in the case of a 5 per cent. nickel metal, one has to legislate for covering a 7½-cwt. casting, but next time only for 5 cwts. It was necessary to take the cost of all being made. If 5 per cent. of nickel had to be costed each day, at the end of the week the cost would be taken to give total cost for the week.

Scrap at Pig-Cost

MR. J. LONGDEN said that he thought the sub-committee had not put forward altogether a cast-iron case, but at the same time thought the report was very complete. He did not quite understand how they came to recommend the charging of the returned scrap at the price of pig-iron, because it did not cost that amount. Scrap was originally a blend of pig-iron and bought scrap. Why, then, value it at the cost of the pig?

MR. HODGSON replied that the committee on the whole were not unanimous on this point. In fact, on this point he was not quite in agreement with other members of the committee. Mr. Hodgson then read a draft of the committee's reply on this point to discussion at another Branch. He himself was not prepared to value the returned scrap at the cost of pig-iron or to accept its value as it is put on the floor. That was his opinion, and he wished to have the opinion of the members to put before the committee.

MR. R. S. JEFFREY said that all the scrap made to-day was used to-morrow, so if the pig and bought scrap remained fixed the best way to take the value of returned scrap was over a period. He took it over one year. They kept the scrap from separate mixes and used each in its own mix. If they used a mixture of 20 per cent. of one pig and 20 per cent. of another at two prices and 30 per cent. bought scrap they then had definite prices for 3 parts or 70 per cent. of which they knew the cost and take the cost of returned scrap at that. If they had 20 per cent. of a pig at £5 per ton, 20 per cent. of a pig at £4 per ton, 30 per cent. returned scrap (no price), 30 per cent. bought scrap at £3. Total that they had the price of 70 per cent. of the mix and ten-sevenths of that gave the total cost of the mix. They took average prices of two pig-irons and of bought scrap. In regard to the oncost of 1s. 6d. per ton mentioned in the report he would like to ask how much that covered, as it seemed low.

MR. HODGSON said the 1s. 6d. was not a record of actual figures.

MR. JEFFREY said he would be interested to know a working figure.

MR. HODGSON asked how Mr. Jeffrey regarded the figure of 12s. 4d. given for melting costs.

MR. JEFFREY said there again he would like to have an idea of what that figure included.

MR. HODGSON said the figure was not necessarily accurate, but he thought that 12s. 4d. was a reasonable figure and one which agreed very well with his own experience.

MR. JOHN CAMERON, junr., asked if it was reasonable to expect that the committee would be able to give them certain figures representing good working? They had, for instance, definite values for sands, etc.; could they similarly obtain figures for melting costs giving sub-divisions labour, patching, etc., so that the foundries could compare the committee's figure with their own figures and so improve their practice?

MR. HODGSON said it had not been done, but he could see many snags if it was attempted. The different price for coke, labour, ganister, etc., in different localities. Some foundries would use cheap coke and some would go to Wales for it. He could scarcely see that it could be done except for districts. He could not see how they could give any general figure for the whole country.

* FOUNDRY TRADE JOURNAL, November 8, 1934, page 290.

Silicosis and the Minerals Causing It

REMEDIAL MEASURES SUGGESTED

Silicosis—a disease which has occurred to a varying extent in some sections of the mineral industries, among rock workers, and so on, and which arises from the inhalation of silica dust and compounds containing it—was dealt with in lectures before the Southern Section of The Institute of Vitreous Enamellers, at a meeting in the British Industries House, Marble Arch, London, W.1, recently. Dr. E. L. Middleton, M.D., D.P.H. (H.M. Medical Inspector of Factories), dealt with the disease itself, and Dr. W. R. Jones, D.Sc. (Lond.), F.G.S., M.I.M.M., discussed the minerals which cause it. Mr. B. B. Kent presided.

Silicosis

Dr. Middleton began by pointing out that when dust was inhaled into the lungs to an injurious extent, disease resulted, which interfered with the function of the respiratory system and finally crippled health and working capacity, and, in some cases, eventually caused death.

Having discussed briefly the mechanism of the function of respiration and the manner in which the inhalation of dust affected this mechanism and function, and indicated how the air breathed was warmed, moistened and cleaned before reaching the delicate structure of the lungs, he said the nasal passages provided the first line of defence. The value of the nose as a dust filter varied with different individuals within very wide limits. The nose-breather had at least some advantage over the mouth-breather, in dusty atmospheres, during moderate exertion, but with heavy manual exercise most people became mouth-breathers, so that the warming and moistening effects of the nasal passages were lost. He explained the further cleaning of the air as it travelled along the trachea and bronchial tubes after it had passed through the nasal passages, and the process by which the living cells, known as phagocytes, removed particles admitted with the air breathed. The success of these cells in removing the dust particles depended on the amount of dust they had to deal with and the kind of dust. If it be too great in amount the cells could not clear it all away, so that some remained lying in the lung tissues. Or, if the dust be of an injurious kind, the phagocytes appeared to be poisoned by it, and when they died in the lung tissues the dust they contained was deposited there and gave rise to certain changes in the tissues.

There were two important classes of dust: the inert dusts which the phagocytes could remove effectually, or, if removal were imperfect, no serious change was produced in the lung tissue in which the dust was deposited. The other class included the injurious dusts which destroyed the phagocytes and gave rise to inflammatory changes in the lung tissue. But these two classifications were only relative. It could be said that all dust was injurious, because all dust produced a reaction in some degree, but there were very wide and important differences in the degree of reaction produced.

The most injurious forms of dust were represented by silica and compounds containing it, which caused silicosis. An inflammatory reaction was produced by the irritant, poisonous action of the dust, and this gave rise to the formation of a kind of scar tissue, called fibrous tissue, with a tendency to spread and replace the delicate cellular structure of the lungs by dense masses of fibrous tissue. This process continued simultaneously at numerous points, and these, growing peripherally, tended to coalesce, with the result that large portions of the lungs were rendered useless for respiration. As more and more lung tissue was involved, the pulmonary blood vessels were reduced in capacity, and symptoms of shortness of breath appeared, and finally the heart became affected. Lungs which were the seat of fibrosis due to silica dust were much more liable to be seriously affected by infections. The most important of these was the tubercle bacillus, which appeared to spread more rapidly in silicotic lungs, so that in a majority of fatal cases of silicosis, tuberculosis was present and was frequently the determining cause of death.

Besides the composition or mineral nature of the dust, the size of the particles of which it was composed was also important. The natural protective mechanism of the air passages was well adapted for catching the larger dust particles, but the extremely fine particles that were present in industrial dust clouds could pass in the air stream and reach the alveoli or air-sacs. Such particles were those under 10 μ in diameter. In the occupation of dressing sandstone with a hammer and chisel, for example, 99 per cent. of the particles given off in the dust cloud were of a size below 5 μ at the breathing level of the mason. In other industries the same type of size-frequency of particles was found—he mentioned pottery, the grinding of metals on wet sandstones, drilling hard headings in coal mines, and dry flint crushing.

After describing an instrument, known as the thermal precipitator, developed at Leeds University and adapted for dust measurement under the auspices of the Medical Research Council, whereby the concentration of a dust cloud could be determined—it took a sample over a period of from 30 to 60 min., so that an average of the concentration over that time was obtained—Dr. Middleton said the number of particles in dust clouds varied very widely, from less than a hundred to several thousands in a cubic centimetre. With ordinary breathing, about 500 cubic centimetres were inhaled with each breath, so that the number of particles gaining access to the lungs in a working day was enormous. The period of time during which a worker was exposed to a dust cloud, therefore, was another factor of importance. The success of the protective mechanism to guard the lungs from injury was at best only partial, and with injurious dusts the struggle was unequal and the result sooner or later was inevitable.

One feature of this type of lung disease was the period of delay in its development. The fibrosis resulting from the inhaled dust took time, usually a few years, to become established, and in the majority of cases several years elapsed before any symptoms were recognised. But the formation of fibrous tissue in the lung did not cease when the workman was removed from the dust cloud; it continued so long as dust remained in the lungs. At any time in its progress, tuberculosis or acute infection might supervene in the damaged lungs and aggravate the symptoms.

It was not possible to estimate accurately the extent of the disease, but reliable sources indicated that over 300 deaths occurred every year in England and Wales from this cause. The disease progressed slowly, and some degree of disablement appeared long before it proved fatal. Over £100,000 was paid in compensation in a single year in this country.

There was no remedy for the disease, once the lungs had become affected. The only alternative was prevention, which could be effected by (1) avoidance of injurious materials; (2) suppression of dust at its source; (3) removal of dust as nearly as possible to the point of origin; and (4) protection of the workman.

It was not always possible to avoid the use of injurious materials, and in the enamelling industry it might be that siliceous materials were essential. The use of lead compounds had been given up to some extent, however, with a gratifying result as regards the incidence of lead poisoning, and it might be possible to avoid also some of the most dangerous of the silicosis-producing materials.

The suppression of dust at the source was most usually effected by using enclosed machines or by adopting wet methods. It was important to realise, however, that in spraying finely-ground material suspended in a liquid medium, it was possible that particular matter was disengaged from the spray and would be inhaled by workers in the vicinity unless exhaust draft were effectively applied.

Removal of dust at the point of origin required a carefully-designed and well-maintained system of mechanical exhaust draft. Some processes did not appear to lend themselves to the application of localised exhaust draft, but it was surprising what could be done by expert ventilating engineers.

The last resort was the protection of the workman by a breathing apparatus or respirator. For certain manipulative processes carried on away from a fixed point the use of such an appliance might be necessary. The best arrangement was one which allowed the wearer to breathe air from a pure source, brought through a tube, preferably under slight pressure. These appliances were often irksome, and tended to be laid aside, so that willing men must be selected for work requiring this provision. The other protective appliances were respirators. Only those of known efficiency should be used, and perfect fit was essential. Experiments were in progress for the development of a reliable respirator providing a reasonable degree of comfort, but some months must elapse before it was available. Where this measure was relied upon, no unprotected person must be allowed in the room while the process was being carried on and until the atmosphere had been cleared of dust by suitable ventilation.

The Minerals Causing Silicosis

Dr. Jones, dealing with the minerals causing silicosis, first presented various data, including analyses of the inorganic mineral dusts found in silicotic lungs, to disprove the theory, which was held at one time, that only free silica dust would cause silicosis. He emphasised that silicosis was caused by the minute fibres of mineral sericite, which was released when silica, quartz or flint or felspar were broken. One crystal of felspar, for instance, would produce myriads of fibres of sericite of the same size and shape as those found in the lungs of men who had died of silicosis. The rock would break along the easiest path, *i.e.*, through the part which was sericitic, and the fibres were so small that, once they were freed into the atmosphere, they remained suspended for many hours. Their average size was only $\frac{1}{25000}$ of an in. They were released merely by breaking the rock.

Dr. Jones mentioned the banket rock met with in some of the gold mines of South Africa, which had been responsible for a great deal of trouble. In between the quartz crystals there were myriads of the sericite fibres, and, in spite of the precautions taken in the way of wet drilling, water spraying, good ventilation, and so on, as much as £1,200,000 was paid in compensation in respect of silicosis in one year. On the other hand, at the Kolar goldfields in India, where about 12,000 people were working underground, and where quartz veins had to be dealt with, there had been very few cases of silicosis, perhaps 3, 4 or 5. Yet the rock contained more quartz than that in South Africa, and the ordinary dry-drilling methods were applied. Discussing the reason, he said there were no fibres of sericite between the quartz grains, as indicated by the petrological microscope; the rock did not contain particles sufficiently small to enter the lungs.

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Micro-photographs of dust deposits on glass slides coated with balsam, which slides had been exposed, in October, 1933, in one of the best-ventilated mines in South Africa, indicated the manner in which the sericite fibres remained suspended in the air. A slide was exposed a quarter of an hour after blasting, and other slides were exposed at intervals afterwards, and examination of them indicated that the quartz particles were settling gradually, so that the percentage of sericite fibres in the air became greater on each succeeding slide. In the mines in South Africa the men worked for only one shift per day, and blasting was allowed only at the end of each shift, so that 16 hours elapsed between the time of blasting and the time at which the men resumed work next day. Some of the fibres settled during that time, but the majority did not; so that there were always fibres in the atmosphere.

Dr. Jones then illustrated a sample of the rock from a mine at Broken Hill, New South Wales, which was the worst in Australasia from the point of view of the incidence of silicosis; yet the percentage of quartz in the rock was very small. The trouble was due to the sericite in it, together with another mineral which occurred in a fibrous condition, *i.e.*, sillimanite, sometimes call fibrolite. Research had shown that the residues in lungs of men who had worked there consisted mainly of sericite, a certain amount of quartz and a certain amount of sillimanite. He had no doubt that quartz and flint could produce silicosis if it were powdered sufficiently finely to enter the lungs; but usually the material floated about, small enough to enter the lungs, in places where silicosis occurred, was mainly sericite. He also quoted statistics relating to the pottery trade, to show that people who had never handled flint dust had died of silicosis. Kaolin came from the decomposition of felspar, and in kaolinisation there was liberation of sericite.

Coming to preventive measures, he said that arrangements for exhausting dust-laden air, dust traps used underground, and so on, were helpful; but he was not satisfied. They ought to aim at 100 per cent. extraction; then, if they fell short, they should probably get nearer to perfection than they should if they aimed at less. In underground workings abroad he had seen men drilling rocks with machines supplied with fresh air from the surface, but such fresh air was not supplied to the men, who continued to breathe the dust. He had never yet heard of any difficulty which was insuperable or even very serious in the way of supplying the men with fresh air from the surface. There was nothing simpler than to connect a man, by means of a flexible tube on a light belt, to an air-pressure pipe, using a reducing valve. If the man were provided with a very light cover over nose and mouth, and if the air were led to it under positive pressure, he could breathe as freely and easily as if he were in the open air. Whilst Dr. Jones did not claim any originality about that suggestion, he did claim to have been instrumental in getting it installed in one asbestos factory in this country. After two or three weeks of experiment the users had begged to be allowed to continue using it, because for the first time they were kept cool around the face; there was no condensation of moisture, as with a respirator, and he considered it a 100 per cent. preventive. Perhaps it could not be used by the few people who had to walk considerable distances about factories, but the majority of the workers, especially in well-organised factories, had not to walk long distances; one could always walk a few yards when wearing such an apparatus attached to a flexible tube. It was very simple and very inexpensive. All that was needed for experiment was a light compressor—even a fan would be sufficient for one or two people—a few yards of flexible hose, and a very light cover for nose and mouth, which could be obtainable from well-known firms. He emphasised that it was not a respirator; he had never yet seen any type of respirator that he could possibly wear underground in a hot mine, and it was even uncomfortable in a surface factory.

At the conclusion of the meeting a hearty vote of thanks was accorded Dr. Middleton and Dr. Jones, and it was intimated that they would be glad to answer questions submitted in writing.

Effect of Slag Composition upon the Structure of Cast Iron

An investigation into the effect of slags of varying composition upon the structure and mechanical properties of cast iron has been carried out by E. Diepschlag and M. Michalke.* Heats of about 10 kg. in weight were melted in an electric-arc furnace under slags containing various percentages of silica, lime and alumina. Several hematites, foundry pig-iron and a white iron were used as raw material. Bars of different diameter for the mechanical test, metallographic examination, and thermal analysis, were cast in sand and chill moulds. The total of carbon and silicon of the cast bars varied from 5.5 to 7.0, the melting temperature from 1,420 to 1,600 deg. C. The melting time was about 1 hr.

For simplification the different types of structure found in the bars were divided into three main groups:—(*a*) Normal graphite in a pearlitic ground mass; (*b*) finely-divided graphite in a ferritic ground mass (graphite eutectic); (*c*) coarse graphite in a ferritic ground mass (decomposition ferrite). Only few bars contained only one type of structure. In the majority of cases the three types were co-existent, the pearlite (*a*) surrounding in the form of a network round areas of graphite eutectic (*b*) or decomposition ferrite (*c*). The area occupied by each type was estimated and expressed in percentages of the total area. A relationship between the structure and the melting temperature, the pig-irons used, or the composition of the bars (C + Si) could not be established. However, by plotting the results of the structural analysis into the slag triangle, the following relationships were found:—(1) Lime-alumina slags with 35 to 65 per cent. of lime and a low silica content produce normal graphite in a pearlitic ground mass. With silica over 10 per cent., the graphite eutectic appears in varying amounts. (2) Lime-silica slags with a high lime content preferably produce the graphite eutectic, also in melts high in phosphorus. (3) Lime-silica slags with a high silica content produce decomposition ferrite with coarse graphite.

The action of the slags mentioned in subsection (2) is, according to the authors, due to their ability of reducing the quantity of non-metallic inclusions in the melt. Such inclusions were found in rather large quantities in the chill-cast bars of the melts exhibiting the structures (*a*) and (*c*), but only few could be detected in the melts (*b*). As a consequence, the sand-cast bars of the melts (*b*) solidified after supercooling, rejecting the graphite in a finely-divided form. The eutectic temperatures were found to be as follow:—Melts (*a*), about 1,150 deg. C.; melts (*b*), about 1,140 deg. C.; melts (*c*), about 1,160 deg. C. As the authors show, the different behaviour of pig-irons of the same analysis as well as their "inherent" properties must also be attributed to the presence of non-metallic inclusions.

The poorest strength properties showed the bars which contained more or less decomposition ferrite and coarse graphite. The lowest figures were:—Tensile strength, 7.1 tons per sq. in.; transverse strength, 13.4 tons per sq. in.; deflection, 0.315 in.; Brinell hardness number, 111. The highest strength figures were obtained with the bars containing nearly 100 per cent. of pearlite with normal graphite. The figures lay in the following range:—Tensile strength, 14.7 to 23.4 tons per sq. in.; transverse strength, 26.5 to 36.2 tons per sq. in.; Brinell hardness number, 173 to 242. The bars, the structure of which consisted almost entirely of graphite eutectic, are remarkable inasmuch as they showed good strength properties (tensile strength 17.2 tons per sq. in., transverse strength 28.7 tons per sq. in.), coupled with a low Brinell hardness (160). They exhibited a very smooth surface, like castings made of charcoal iron, and could be very easily machined. As they contain only ferrite and finely-divided granular graphite, they do not grow when exposed to high temperatures. As yet, such a structure could only be produced by casting a high-silicon iron into chill moulds. The possibility of obtaining this structure in any sand casting by a simple slag treatment of the iron, means a marked advance in the manufacture of high-grade castings.

* "Die Giesserei," 1934, Nos. 47-48.

Notes from the Branches

Scotland.—The Scottish Branch has now completed 25 years' existence, having been started on February 16, 1910. At the annual general meeting on March 9, Mr. A. Campion presented to the Branch a silver-mounted chairman's gavel for the use of the chairman at meetings and functions in recognition of the anniversary.

In making the presentation, Mr. Campion said that from time to time suggestions had been made that Branch-Presidents should be provided with a badge or some other form of decoration, but none of them had been favourably entertained. Personally, he thought that there were too many chains, ribbons and badges in the Institute already, but nevertheless he had a feeling that the President might have some emblem of his authority. During one of the discussions which had been held the secretary had suggested that a chairman's gavel would be a suitable thing for the Branch to possess. He had recently recalled that suggestion, and in view of the completion of the 25th year of the Scottish Branch, and that he had been privileged to be in intimate and active association with its various activities, he decided to ask the Branch to accept a silver-mounted gavel from him as slight appreciation of the pleasant and profitable association he had had with the Scottish Branch and the many friendships which he had formed during the past 25 years. He hoped that in the future the Branch would progress to an even greater extent than it had done in the past. The time had come when the younger men must take control and carry on the work which had been started during the last quarter of a century.

Mr. H. Hurst, Branch-President, in accepting the gavel on behalf of the Branch, said that no one could have made the presentation with more grace and dignity than Mr. Campion, and he was sure that every member would appreciate the interest which he had always taken and the work which he had performed for the good of the Branch over the long period of years.

Mr. D. Sharpe said that he would like to support the chairman's thanks to Mr. Campion for his kindly gift, which would add to the dignity of their meetings. He preferred to regard the gavel not so much as an instrument for calling the meeting to order as a signal for calling their younger members to action. He hoped the young men who would have to carry on the work of the Branch during the next 25 years would respond to the signal and take part in their proceedings and join in the discussions at the meetings.

Negotiations are proceeding between Russia and Hungary for the exchange of Russian pig-iron for Hungarian products. Last year Russia entered the pig-iron trade, and the largest order booked to date is that of 100,000 metric tons for delivery to Japan.

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Symposium on Welding Iron and Steel

As previously announced, a "Symposium on the Welding of Iron and Steel" will be held (by kind permission) in the Lecture Theatre of the Institution of Civil Engineers, on Thursday and Friday, May 2 and 3, at 10 a.m. each day, under the auspices of the Iron and Steel Institute, in co-operation with the following societies:—The British Iron and Steel Federation, the British Steelwork Association, the Institute of British Foundrymen, the Institute of Marine Engineers, the Institution of Automobile Engineers, the Institution of Civil Engineers, the Institution of Electrical Engineers, the Institution of Engineers and Shipbuilders in Scotland, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institution of Structural Engineers, the Institution of Welding Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Royal Aeronautical Society, and the South Wales Institute of Engineers. The full list of Papers, and the groups into which they have been divided, are given below. The programme of the presentation and discussion of the groups and sub-groups is as follows:—

Thursday, May 2

Morning, 10 *a.m.*—Group 1 (*a*): Present-day practice and problems of welding in the Engineering industries: bridge and structural engineering, pressure vessels, railway material, shipbuilding.

Afternoon, 2.30 *p.m.*—Group 1 (*b*): Present-day practice and problems of welding in the engineering industries (continued): aeronautical, automobile, chain and electrical industries, iron and steel castings and wrought iron.

Friday, May 3

Morning, 10 *a.m.*—Group 2: Welding practice and technique and welding apparatus. Group 3: The metallurgy of welding.

Afternoon, 2.30 *p.m.*—Group 4: Specification, inspection, testing and safety aspects of welding.

As the result of the information and experience disclosed at the Symposium, it is the intention of the Committee to draw up a report to include their suggestions for the organisation of future research.

Advance copies of the Papers are being prepared; the charge for these is 2s. 6d. per copy for each group or sub-group, as indicated in the list of Papers below, or 10s. 6d. for a complete set.

Conversazione and Dance

On Wednesday evening, May 1, a conversazione will be held in the Science Museum, South Kensington (by kind permission of the director), in order to open the Symposium. Technical films on welding will be shown during the evening, and an exhibition of welding apparatus arranged, with the kind assistance of the industry. On Friday evening, May 3, a dance will be held at Grosvenor House, Park Lane.

Those intending to take part in the Symposium are requested to send in forms of application for tickets, and also orders for advance copies and bound volumes as early as possible.

List of Papers Promised

About 133 Papers have been promised, and the following should be of special interest to our readers:—"The Reclamation of Grey-Iron Automobile Castings by Welding," by V. C. Faulkner (Institute of Britsh Foundrymen); "Welding of Wrought Iron," by J. E. Fletcher; "The Welding of Cast Iron: Some Metallurgical Considerations," by J. G. Pearce (British Cast Iron Research Association); "Welding for Steel-Casting Industry," by V. G. Pearson (Edgar Allen & Company, Limited); "Special Problems in the Welding of Steel Castings," by A. M. Roberts (Metropolitan-Vickers Electrical Company, Limited); "Welding in British Railways (Mechanical Engineering)," by W. A. Stanier (on behalf of the G.W.R., L.M.S., L.N.E.R., L.P.T.B. and S.R.); "Welding in Relation to Automobile and General Repair Work," by C. W. Brett (Barimar, Limited); "The Metallurgy of the Welding of Alloy Steels," by W. H. Hatfield (Thomas Firth & John Brown, Limited); "Steelmaking in Relation to Weld Rod Manufacture," by T. Swinden (United Steel Companies, Limited); and "Eye Protection in Welding," by W. Watson (S. Pulzer & Son).

An Acid-Resisting Vitreous Enamel

We have received from the Ferramic Industries, Limited, Hydeway, Welwyn Garden City, Herts, details of a test carried out by a company of unquestionable integrity with the object of ascertaining the acid-resisting properties of "Ferramic" enamels. To two gas-cooker tops were applied twenty "chemicals" equidistantly around the periphery. They were (1) jelly for cleaning cookers; (2) ferrous-sulphate solution; (3) potassium permanganate; (4) nitric acid; (5) tea; (6) ferrous sulphate and sodium hydroxide solution; (7) concentrated solution of potassium hydroxide; (8) concentrated solution of sodium hydroxide; (9) concentrated solution of tannic acid; (10) 10 per cent. solution of sodium hydroxide; (11) violet dye; (12) green dye; (13) concentrated solution of sulphuric acid; (14) concentrated solution of nitric acid; (15) solutions of iron, alum, and potassium ferrocyanide; (16) 10 per cent. solution of sulphuric acid; (17) 10 per cent. solution of nitric acid; (18) glacial acetic acid; (19) concentrated solution of oxalic acid, and (20) concentrated solution of hydrochloric acid. The report states that "after seven days the chemicals were washed off. As there was no visible effect, the temperature of the cooker (was) raised to about 50 deg. C. for 6 hrs., the chemicals being then removed."

We are also informed that this enamel can be applied direct to cast iron without the use of a ground coat. The fusing temperature does not exceed 780 deg. C., a factor of importance in connection with liability to chip. Taken together, these claims do constitute matters of great interest to the vitreous-enamelling industry. Visual inspection, we are informed, revealed that only the 10 per cent. caustic-soda solution had had any effect whatsoever.

Publication Received

The Mellor Laboratories of the British Refractories Association. In connection with the opening of the Mellor Laboratories at Shelton, Stoke-on-Trent, a brochure has been published.

Early in the book is detailed the programme of research originally devised by Dr. Mellor in 1920, and which stands to-day as the Association's fundamental working basis. After this follows a list of 189 Papers and reports and 35 confidential bulletins, all of which have been produced in fourteen years, with a revenue of about £4,500 per annum—an excellent record. Then follows a description of the new laboratories, whilst the closing pages are devoted to a report of the speeches made at the inaugural luncheon.

THE WILLINGTON FOUNDRY COMPANY, LIMITED, is being wound up voluntarily. Mr. Ernest Robinson, 16, Market Street, Newcastle-upon-Tyne, is the liquidator. (This is a members' voluntary winding-up, and all creditors have been, or will be, paid in full.)

The Cast Iron Report Examined

SHEFFIELD FOUNDRYMEN CRITICAL

At a meeting of the Sheffield and District Branch of the Institute of British Foundrymen, held recently, Mr. P. A. Russell, B.Sc., presented the report of the Cast Iron Sub-Committee of the Technical Committee of the Institute, which was published in the June 28, 1934, issue of THE FOUNDRY TRADE JOURNAL, and afterwards dealt with points raised in the subsequent discussion.

Mr. J. E. Hurst, the Branch-President, who was in the chair, suggested that future researches would have to be in the direction of the ascertainment of the fundamental causes of porosity.

MR. J. ROXBURGH queried a casting temperature of 1,300 deg. C., and whether the use of ferro-silicon did not have an innoculation effect similar to that brought about by calcium silicide. He asked whether phosphorus had the effect of inhibiting high-carbon contents. He was anxious to have more work done on the correlation of porosity with freezing ranges, and also with manganese content.

MR. RUSSELL, speaking personally, thought that freezing range now associated with low-carbon and phosphorus contents eliminated porosity. As to the effect of manganese in porosity, no conclusive evidence was available, but it was worth investigating.

MR. WHITEHOUSE confirmed that, from personal experience, there was no dangerous range with phosphorus between 0.4 and 0.8 per cent.

MR. RUSSELL agreed that there was no dangerous range provided that the carbon content was controlled at 3.2 per cent. maximum, and pointed out that the proportion of 3.3 per cent. carbon and 0.3 per cent. phosphorus could only be considered correct for one type of iron, and further tests might be required for the types of iron used by Mr. Whitehouse. He had formed the opinion that it was a case of 90 per cent. composition and 10 per cent. origin. He emphasised the fact that the Report detracted from the importance of silicon as a factor in porosity and stressed the *rôle* of phosphorus.

A vote of thanks to Mr. Russell concluded the proceedings.

Institute of Metals

The annual dinner and dance of the Institute of Metals was held at the Trocadero Restaurant last Wednesday, under the presidency of Dr. Harold Moore, C.B.E. Speeches were made by Sir Richard Redmayne, K.C.B., President of the Institution of Civil Engineers, Dr. Richard Seligman (Past-President) and Sir Clement Hardy, K.C.I.E. Amongst those present prominent in the foundry industry were Mr. Roy Stubbs, President of the Institute of British Foundrymen, Mr. A. Harley and Mr. V. C. Faulkner (Past-Presidents of the Institution of British Foundrymen), Prof. J. H. Andrew, D.Sc., Mr. H. W. Lockwood, Prof. D. Hanson, D.Sc., Mr. J. F. Kayser, Dr. A. L. Norbury, D.Sc., Mr. H. B. Weeks (chairman of Council, B.C.I.R.A.), Mr. A. J. Murphy, M.Sc., Capt. Geo. Mortimer and Principal G. Patchin. A thoroughly enjoyable evening was spent and this function is unquestionably one of the most appreciated of those arranged by the scientific institutes.

MESSRS. H. HENDRA & SON, Beddington Lane, Croydon, Surrey, inform us that their telephone number has been changed to Thornton Heath 1416 (two lines).

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This Week's News in Brief

Trade Talk

PARTICULARS ARE ANNOUNCED of an issue at par of 400,000 5 per cent. cumulative participating redeemable preference shares of £1 each and 40,000 ordinary shares of 10s. each in the Universal Grinding Wheel Company, Limited. Sir John Field Beale is chairman of the company. All of the preference and ordinary shares have been placed privately.

ON MONDAY, MARCH 4, the petition by the Glanmor Foundry, Limited, of Llanelly, for the compulsory winding-up of Davy Bros., Limited, of Sheffield, again came before Mr. Justice Bennett in the Companies' Court. As the scheme of arrangement was not ready, the petition was again allowed to stand over until April 15, the last day of the present sittings.

THE SCOTTISH IRON & STEEL COMPANY, LIMITED, increased its net profit after allowing for depreciation, from £21,000 in 1933 to £46,209 in 1934. The profit allows for income-tax, bad debts and all other charges. The company operates iron and steelworks in the Coatbridge area, and its progress is taken as an indication of the trade in other Scottish areas.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION announces the selection of Toronto, the largest foundry centre in the Dominion of Canada, as the venue of the 1935 convention of the Association. The dates will be August 19 to 23, inclusive. This meeting, at which there will be no exhibition, will be devoted to technical sessions, shop courses, round-table discussions, committee meetings, plant visits, and numerous social functions.

IT IS OFFICIALLY ANNOUNCED that Messrs. Hurst Nelson & Company, Limited, have received a valuable rolling-stock contract from the London & North Eastern Railway Company, which will keep the Motherwell works employed to full capacity for some months. The order is for 250 closed goods vans and 250 open wagons, to a value of about £80,000. The firm are also engaged on the construction of a number of all-metal tramcars for the Edinburgh Corporation.

AT THE ANNUAL MEETING of the American Institute of Mining and Metallurgical Engineers, held in New York, the development of a new metal, "aluminium-monel," was described by Dr. W. A. Mudge, metallurgist of the Huntington, W. Va., works of the International Nickel Company, and Dr. Merica. The new metal resembles Monel metal, but has an added 4 per cent. of aluminium. It is thought that the "aluminium-monel," with its high strength and good mechanical properties, can be valuable for such applications as turbine blades and pump rods.

MESSRS. WILLIAM BEARDMORE & COMPANY, LIMITED, Parkhead Forge, Glasgow, have just delivered a new stem-piece for the cruiser "Renown" to replace the one damaged recently when the vessel collided with the battle cruiser "Hood." The stem, which measures 40 ft. by 21 ft., and weighs 14 tons, has been completed ready for despatch in 20 days, which is eight days less than contract time. To ensure the safe transport of the casting through the five miles of streets from Parkhead to the shipping berth at the Broomielaw, the police made special traffic arrangements.

THE NEW FACTORY of Irish Metal Industries at Earls Island, Galway, for the manufacture of sporting ammunition and certain other chemical products, has been completed. About 70 persons will be employed at the start, and this number will be gradually increased with the demand. The new company will have the support and technical assistance of Imperial Chemical Industries, Limited. The directors of the company are Messrs. John Irwin, Dublin; G. W. Milne, Dublin; F. G. Meagher, Dublin; and A. M. Kempson, Swansea. In addition to the above-mentioned products, certain non-ferrous metals will also be turned out. Arrangements have been made for the importation of explosives.

THE ORDER for the engining of 24 lifeboats for the Cunard White Star liner "Queen Mary" has been placed with Messrs. John I. Thornycroft & Company, Limited, of Glasgow. The installation of the engines has been so arranged that, by means of electrical heaters, the engines will be kept at a constant warm temperature ready for instant starting. The propelling machinery for the lifeboats represents a big advance on the power units of previous motor lifeboats, the engines of which could not be started up until the boats were in the water on account of no water being available for circulating through the jackets. In the "Queen Mary's" installation each engine, with all the gear, is contained inside an insulated watertight compartment, which ensures the engines working even if the boats are flooded with water.

PLANS FOR THE ESTABLISHMENT of a general iron foundry for the output of ranges, grates, rain-water pipes and general ironwork, have been completed by a company in Sligo, and work on the erection of the necessary buildings will commence immediately. A site has been approved by the local authorities about a mile from the town, and the plans will provide for extensions when necessary. In addition to its output, the new works will give considerable indirect employment at the docks, as all the raw material required will be imported locally. It is expected that in its initial stage the foundry will employ about fifteen hands and, when in full swing, at least 100. Mr. John O'Regan, of Cork, who has had extensive experience of foundry work, has been appointed manager, and has paid a visit to Glasgow to superintend the shipping of the plant.

Company Reports

English Electric Company, Limited.—Trading profit £172,214; debenture interest and other charges, £90,312; depreciation, £50,000; net profit, £31,902; debit brought in, £277,270; debit balance carried forward, £245,368.

Scottish Iron & Steel Company, Limited.—Profit, £54,835; brought in, £1,350; to depreciation account, £8,626; to special reserve fund, £4,499; preference dividend, £13,950; final dividend on the ordinary shares of 4 per cent., making 6 per cent. for the year, £14,880; carried forward, £6,790.

Brown, Bayley's Steelworks, Limited.—The directors have declared six months' dividend on the 5 per cent. tax-free preference shares on account of arrears.

Cammell, Laird & Company, Limited.—Profit for 1934, £29,173; brought in, £3,005; payment of 2½ per cent. made on the 5½ per cent. debenture stocks; carried forward, £2,565.

Baldwins, Limited.—Trading profit (subject to final audit) for 1934 of £502,642. The directors have decided, after provision of £65,363 for redemption of convertible income debenture stock, to pay for 1934 the dividends on the 6 per cent. "A" preference and on the 7 per cent. "B" preference shares, and to recommend payment of a dividend on the ordinary shares at the rate of 2½ per cent., less tax.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Oxford & Cowley Ironworks, Limited, Cowley, Oxford.—Capital £10,000. Iron and brass founders. Director: F. Church.

Henry Slack & Sons, Limited, The New Factory, Church Street, Accrington.—Capital £10,000. Engineers, founders and machinists. Directors: R. Slack and C. Slack.

Thomas & Isaac Bradley, Limited, Heath Road, Darlaston, Staffs.—Capital £100. Ironmasters, colliery proprietors, blast-furnace proprietors. Directors: G. T. Lunt and R. W. Hale.

Contracts Open

Carlisle, March 23.—For the Border Rural District Council:—About 1,860 yds. 3-in. dia. water mains. The Clerk, Rural District Council, 7, Victoria Place, Carlisle.

Clitheroe.—Cast-iron water mains, with the necessary valves, hydrants, etc., for the Rural District Council. The surveyor, W. G. Booth, 23, Church Street, Clitheroe.

Personal

THE BESSEMER GOLD MEDAL of the Iron and Steel Institute for 1935 has been awarded to Prof. A. M. Portevin, Directeur de l'Institut de Soudure Autogène, Professeur à l'Ecole Supérieure de Fonderie, et à l'Ecole Centrale des Arts et Manufactures.

THE FOLLOWING have been elected to fill the vacancies on the Council of the Iron and Steel Institute:—Captain I. F. L. Elliot, assistant managing director of the British (Guest Keen Baldwins) Iron & Steel Company, Limited; Mr. E. F. Law, Messrs. Riley, Harbord & Law; and Dr. T. Swinden, director of research, the United Steel Companies, Limited.

MR. THOMAS FLETCHER, foreman of the Horwich Locomotive Works iron foundry, has been appointed foreman of the steel and iron foundries of the Crewe Works. He was the recipient of an electric reading lamp and a pewter tea service from the staff and workmen of the iron and steel and chair foundries of the Horwich Locomotive Works last week, prior to taking up his new appointment.

MR. THOMAS H. DEAN, who for 63 years has been in continual employment at the foundry of Messrs. James Maude & Company, Limited, ironfounders, Mansfield, Notts, holding the post of furnaceman for half-a-century, was the recipient of presentations at a dinner last week. His fellow-employees, 12 of whom had over 40 years' service with the firm, subscribed for and presented Mr. Dean with an easy chair, and Mrs. Taylor, a director, presented him with a cheque on behalf of the directors.

Obituary

WE SINCERELY REGRET to announce the death of Mr. L. P. Sidney, editor of "The Metal Industry." For many years he was assistant secretary of the Iron and Steel Institute, and before that he was on the staff of the "Iron and Coal Trades Review." As a young man he was trained as a metallurgist in the laboratories of one of the large steelworks.

SIR ARTHUR LOWES DICKINSON died suddenly in London on February 28, at the age of 75. From 1888 to 1901 he practised as a chartered accountant in London, going in the latter year to the United States. He was partner in Price, Waterhouse & Company, London, from 1913 to 1924. Activities outside his profession included membership of the Miners' Welfare Committee and directorship of the Ebbw Vale Steel, Iron & Coal Company, Limited. His knighthood was conferred upon him in 1919. Sir Arthur Lowes Dickinson was formerly chairman of Industrial Newspapers, Limited, the proprietors of the FOUNDRY TRADE JOURNAL and numerous other industrial publications.

Forthcoming Events

The Institute of British Foundrymen

MARCH 15.

Lancashire Branch (Junior Section):—(1) Annual general meeting; (2) "Is the Foundry a *Cul-de-Sac*?" Paper by J. E. Cooke, at the College of Technology, Sackville Street, Manchester, at 6.30 p.m.

Sheffield and District Branch:—"Foundry Machinery, with Particular Reference to Sand-Handling Plant," Paper by J. G. A. Skerl, D.Sc., and F. J. Cook, M.I.Mech.E., at the Grand Hotel, Sheffield, at 7.45 p.m.

MARCH 16.

Wales and Monmouth Branch:—Annual general meeting at University College, Newport Road, Cardiff, at 6.30 p.m.

MARCH 23.

East Midlands Branch:—(1) Annual general meeting; (2) "Scab Castings," Paper by B. Hird, at Loughborough College, Loughborough.

MARCH 30.

Newcastle-upon-Tyne Branch:—Annual general meeting at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

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THE "ROCKET" PATENT CORE MAKING MACHINE

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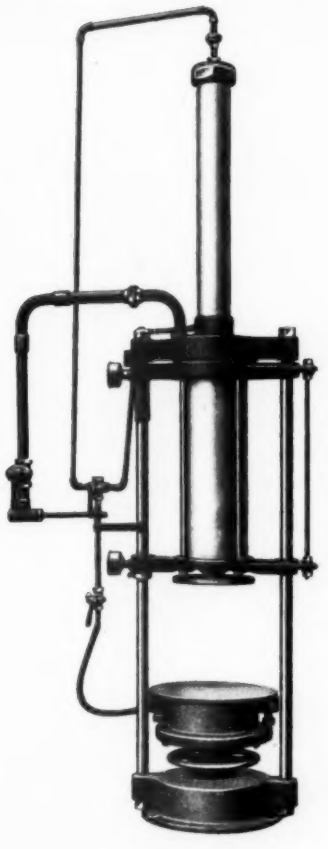

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PREVIOUS OUTPUT
One Core in 17 minutes

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200 Cores in 8 hours

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Raw Material Markets

The current demand for iron and steel has shown little contraction, if any at all, but there is still a disquieting lack of new business, and manufacturers are waiting somewhat anxiously for the spring demand to assert itself. The lull is probably only of a temporary nature so far as the home trade is concerned, but the same cannot be said of the decline in export business. The depreciated sterling has proved to be of little assistance in face of the entanglement of fiscal and financial restrictions erected by Continental nations.

Pig-Iron

MIDDLESBROUGH.—A slight, and probably only temporary, contraction has been reported in the demand for Cleveland foundry iron, and makers have had to make additions to their stocks. Export trading has also been on a very limited basis. The market still retains its confident tone, however, and the fixed minimum prices charged to home consumers have been reaffirmed, the standard No. 3 Cleveland G.M.B. foundry grade being quoted at 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow. For other grades the differential charges are :—No. 1 foundry, 2s. 6d. per ton extra; No. 4 foundry and No. 4 forge, 1s. per ton discount.

It has not recently been possible to dispose of the entire output of hematite, owing to a falling-off in home demands, particularly from the Sheffield area, and to the lack of export orders. However, a speedy improvement is anticipated, and the minimum quotations are being firmly adhered to.

LANCASHIRE.—Reports from this area are slightly more cheerful. Rather larger deliveries of iron are being called for against existing contracts, and several contracts have been arranged which it is hoped will prove to be the forerunner of the spring demand. Values are steady, with Staffordshire, Derbyshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire all quoted for delivery to Lancashire foundries on the basis of 74s. per ton, Northamptonshire being offered at 72s. 6d., Scottish foundry at from about 81s. 6d. to 82s. 6d., West Coast hematite at around 78s. 6d., and East Coast hematite at from 75s. to 76s., according to grade.

MIDLANDS.—The current demand for castings is rather below expectations, and several of the bigger firms in the light-castings trade are still very short of work. Conditions generally are not as good as they were at this time last year. Pig-iron buying is largely limited to small purchases to augment deliveries against existing contracts. The majority of engineering and jobbing foundries are well occupied. The controlled prices for Midland irons delivered Birmingham and Black Country stations and subject to a sliding scale rebate are 67s. 6d. per ton for Northants No. 3 and 71s. for Staffordshire, Lincolnshire and Derbyshire No. 3. Scottish No. 3 is about 85s. per ton, while other low-phosphorus irons of similar analysis are quoted from this level up to 87s. 6d. Medium-phosphorus pig-iron is offered at between 72s. and 80s. per ton. Refined iron for special work is offered at any figure from £5 7s. 6d. per ton.

SCOTLAND.—There is a strong demand for hematite and basic iron on the Glasgow market, but the call for Scottish foundry grades is not so good. No. 3 is still priced at 70s. per ton, f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. The light-castings founders are still busily employed, and they are taking heavy deliveries of Cleveland iron. The latter is quoted at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow, other English irons being obtainable at 1s. 3d. per ton less.

Coke

The foundry-coke market remains very stable. Buying is limited, as so many consumers are under contract to the ovens, a position which has ruled since the beginning of the winter, when at one time there seemed a likelihood of increased quotations. This, however, has not so far materialised. Current quotations for delivery in the Birmingham and Black Country area are as follow :—Best Durham coke, 36s. to 40s.; Welsh, 34s. to 45s.; Scottish low-ash coke, about 40s. per ton.

Steel

Steady conditions rule in the steel markets, and, generally speaking, the volume of business has been maintained at the level ruling for some weeks past. Prices are firm, and in some cases have an upward tendency. The demand for semi-finished steel has improved considerably, and most of the producing works now have well-filled order-books. Not only has there been an expansion in the tonnage of orders placed, but heavy deliveries continue to be made to the consuming works. Business in the finished-materials department has been somewhat patchy. The manufacturers, however, have substantial orders in hand, and can look forward to maintaining the present rate of production for some time to come. Inquiry on export account has appreciably improved, while there is a steady home demand for most descriptions of finished steel.

Scrap

In the Cleveland district there is reported to be a definite scarcity of good machinery metal, and up to 55s. per ton has been paid, ordinary heavy foundry metal fetching 52s. 6d. to 53s. In the Midlands, heavy machinery in cupola sizes is at 55s. to 57s. 6d., good heavy at 50s. to 52s. 6d. and clean light at 47s. 6d. In Scotland, good heavy machinery cast-iron scrap, in pieces suitable for foundry cupolas, is 55s. to 56s., with ordinary cast-iron scrap to the same specification 51s. 6d. South Wales remains the poorest market so far as scrap iron is concerned, the demand being of a limited nature. Heavy cast iron is at 50s. to 52s. and good machinery scrap in cupola sizes at 52s. 6d. to 55s.

Metals

Copper.—A definite increase in confidence has been noticeable in the copper market since it became known that the long-postponed conference of producers was at last to be held. The delegates arrived in New York last Friday, and meetings have already taken place, but no official statement has yet been issued.

Prices have now relapsed slightly, as the demand from manufacturers has been of a limited nature, the majority of buyers preferring to wait and see whether anything comes of the New York conference.

Daily quotations :—

Cash.—Thursday, £28 to £28 1s. 3d.; Friday, £28 1s. 3d. to £28 2s. 6d.; Monday, £28 5s. to £28 6s. 3d.; Tuesday, £27 17s. 6d. to £27 18s. 9d.; Wednesday, £27 13s. 9d. to £27 15s.

Three Months.—Thursday, £28 6s. 3d. to £28 7s. 6d.; Friday, £28 7s. 6d. to £28 8s. 9d.; Monday, £28 12s. 6d. to £28 13s. 9d.; Tuesday, £28 5s. to £28 6s. 3d.; Wednesday, £28 1s. 3d. to £28 2s. 6d.

Tin.—The price of this metal continues to fluctuate from day to day, and the market remains in a nervous state. The exhaustive questions in the House of Commons, and the criticism of the control scheme and the various pools, have combined to produce an atmosphere distinctly inimical to normal trading.

"Consumption in this country is still fairly well maintained, a moderate business being reported from the tinplate trade. On the Continent, some improvement is reported, and relatively higher prices are being paid. In the U.S.A., conditions have been somewhat disturbed by the violent fluctuations in the exchange, and business in consequence has been rather irregular," report Messrs. Rudolf Wolff.

Market fluctuations :—

Cash.—Thursday, £216 to £216 5s.; Friday, £217 10s. to £219; Monday, £217 to £217 5s.; Tuesday, £218 15s. to £219; Wednesday, £219 to £219 10s.

Three Months.—Thursday, £213 to £213 5s.; Friday, £213 15s. to £214 5s.; Monday, £212 10s. to £212 15s.; Tuesday, £213 15s. to £214; Wednesday, £214 10s. to £215.

Spelter.—Dealing in spelter on the London Metal Exchange has been of a desultory nature, and quotations show very little change. The demand from consumers is satisfactory, although current purchases are being made cautiously, in view of the possibility of an early decision being announced by the committee that is inquiring into the present duty on imports of foreign spelter.

Official quotations :—

Ordinary.—Thursday, £11 10s.; Friday, £11 10s.; Monday, £11 10s.; Tuesday, £11 11s. 3d.; Wednesday, £11 12s. 6d.

Lead.—"Prices have advanced slightly, and there appears to be a little more speculative interest in the metal. Otherwise there is no change in the situation," report Messrs. Henry Gardner & Company.

Day-to-day prices :—

Soft Foreign (Prompt).—Thursday, £10 7s. 6d.; Friday, £10 7s. 6d.; Monday, £10 8s. 9d.; Tuesday, £10 7s. 6d.; Wednesday, £10 10s.

Catalogues Received

Aluminium Foundry Data. The British Aluminium Company, Limited, of Adelaide House, King William Street, London, E.C.4, has reprinted this section from their large publication "Aluminium Facts and Figures"—a book which we esteem very highly. This reprint which is meant just for foundrymen, should be in the hands of every non-ferrous worker, and we feel sure that the issuing company will be only too pleased to distribute this gratis to all applicants mentioning this paragraph. Three other reprints are also available bearing the following titles:—"Annealing and Heat-Treatment of Aluminium and Aluminium Alloys," "Aluminium Tubes and Pipes," and "Aluminium Rivets and Riveting."

Electrodes. Messrs. Fairleede Engineering, Limited, of 123, Cannon Street, London, E.C.4, have sent us, enclosed in a neat loose-leaf folder, some very interesting matter relative to arc welding, with special reference to A-Arc coated welding rods. We would remind the publishers of this and other catalogues dealing with electrodes, that where these are meant for perusal by iron and steel founders, it is not wise to emphasise "why use cast iron when steel is cheaper and better?" Primarily it is a loose statement that requires much qualification before acceptation. There are six pages all told, which are very intelligently set out and well illustrated.

Some General Remarks on Mechanised Foundries and the Making of Motor Cylinders

(*Continued from page* 184.)

conveyor (Fig. 10) travels at 21 ft. per min. Particular attention is necessary for the ventilating of the shop, especially taking into consideration the placing of racks of cooling cores where no arrangement is made in the ovens. In the lay-out of the core shop, provision must be made for some storage space, both to allow for detail cores before assembly and a buffer stock for supplying the moulding section.

It is, of course, desirable to keep this to a minimum, but unless some provision is made much delay and confusion will result. Needless to say, the less a core is handled the better, and crowding or packing on trays or conveyors will result in cores rubbed below size or out of shape, and a large proportion chipped or broken.

In cylinder-making, the cores can be delivered to the moulding section either assembled in sets or part assembled on portable racks, belt, or pendulum conveyors, but it must not be overlooked that the cores will require to be taken apart again and blown clean before putting into the mould, and therefore some arrangement should be made for this near the moulding section; this can be done by supplying small benches fitted with air pipes with reduced pressure. Experience has shown that often dirty castings can be traced to the too liberal use of the air pipe with high pressure.

(*To be concluded.*)

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ARE THE GREATEST ECONOMY
YOU CAN INTRODUCE INTO
YOUR FOUNDRY

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THEY SPEED UP PRODUCTION
PRODUCE BETTER CASTINGS
SAVE UNNECESSARY LABOUR

OVER 30 STANDARD DESIGNS OF BOXES

Consult us
AND LET US SOLVE YOUR MOULDING BOX PROBLEMS—

STERLING FOUNDRY SPECIALTIES LTD
BEDFORD

LONDON OFFICE: 13 VICTORIA STREET · WESTMINSTER · S.W.1

RAW MATERIALS—PRICE LIST

(Wednesday, March 13, 1935)

COPPER

	£ s. d.
Standard cash	27 13 9
Three months	28 1 3
Electrolytic	31 0 0
Tough	29 15 0
Best selected	30 5 0
Sheets	58 0 0
India	41 10 0
Wire bars	31 10 0
Ingot bars	31 10 0
H.C. wire rods	34 5 0
Off. av. cash, February	27 4 1½
Do., 3 mths., February	27 9 7½
Do., Sttlmnt., February	27 4 0
Do., Electro, February	30 8 6
Do., B.S., February	30 0 0
Do., wire bars, February	30 12 1½
Solid drawn tubes	9½d.
Brazed tubes	9½d.
Wire	6d.

BRASS

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7⅛d.
Wire	7d.
Rolled metal	6⅞d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN

	£ s. d.
Standard cash	219 0 0
Three months	214 10 0
English	219 10 0
Bars	221 2 6
Straits	221 15 0
Australian (nom.)	—
Eastern	219 2 6
Banca	223 0 0
Off. av. cash, February	227 11 6
Do., 3 mths., February	223 15 7½
Do., Sttlmt., February	227 11 9

SPELTER

	£ s. d.
Ordinary	11 12 6
Remelted	12 15 0
Hard	10 5 0
Electro 99.9	14 3 9
English	12 13 9
India	12 5 0
Zinc dust	17 0 0
Zinc ashes	3 0 0
Off. aver., February	11 18 2¼
Aver. spot, February	11 16 4½

LEAD

	£ s. d.
Soft foreign ppt.	10 10 0
Empire (nom.)	11 10 0
English	12 10 0
Off. average, February	10 6 3½
Average spot, February	10 4 3¾

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	21 10 0
Do., V.M. ex-whse.	22 5 0
Rods	26 0 0

ANTIMONY

	£ s. d.
English	82 0 0 to 83 0 0
Chinese, ex-whse.	71 0 0
Crude	—

QUICKSILVER

	£ s. d.
Quicksilver	11 7 6 to 11 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0
75%	£17 17 6
Ferro-vanadium—	
35/50	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	3/– lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£31 10 0
4/6% car.	£21 15 0
6/8% car.	£21 10 0
8/10% car.	£21 10 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£36 15 0
Max. 0.70% car.	£37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99% (nom.)	5/– to 5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/– lb.
Flats, ¼ in. × ½ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 15 0	to 2 16 0
Bundled shrngs.		2 7 6
Mixed iron and steel	2 10 0	to 2 11 6
Heavy cast iron	2 10 0	to 2 12 0
Good machinery	2 12 6	to 2 15 0
Cleveland—		
Heavy steel	2 11 6	to 2 12 6
Steel turnings		1 15 0
Cast-iron borings		1 5 0
Heavy cast iron	2 12 6	to 2 13 0
Heavy machinery	2 14 0	to 2 15 0
Midlands—		
Light cast-iron scrap		2 7 6
Heavy wrought iron		3 0 0
Steel turnings, f.o.r.		1 14 0
Scotland—		
Heavy steel		2 10 0
Ordinary cast iron		2 11 6
Engineers' turnings		2 0 0
Cast-iron borings	1 17 6	to 1 18 6
Wrought-iron piling		2 12 6
Heavy machinery	2 15 0	to 2 16 0

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	24 0 0
Brass	16 0 0
Lead (less usual draft)	9 10 0
Tea lead	6 10 0
Zinc	8 0 0
New aluminium cuttings	66 0 0
Braziery copper	20 0 0
Gunmetal	23 0 0
Hollow pewter	155 0 0
Shaped black pewter	115 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/–
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/–
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/–
,, No. 3 fdry.	71/–
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/–
,, fdry. No. 3	71/–
,, fdry. No. 1	74/–
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/–
Hem. M/Nos. d/d	71/–
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/–
Staffs fdry. No. 3	74/–
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/–
Clyde, No. 3	82/–
Monkland, No. 3	82/–
Summerlee, No. 3	82/–
Eglinton, No. 3	82/–
Gartsherrie, No. 3	82/–
Shotts, No. 3	82/–

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 10 0	to 8 0 0
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	14 2 6	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ⅝ in. (Untested)	8 12 0	
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)	9 7 0	
Black sheets, 24g. (4-t. lots)	10 10 0	
Galv. cor. shts. (,,)	13 0 0	
Galv. flat shts. (,,)	13 10 0	
Galv. fencing wire, 8g. plain	14 10 0	
Billets, soft	5 10 0	and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 0 0	to 5 7 6
Tin bars	5 2 6	to 5 7 6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11¼d.
Rods	10¼d.
Tubes	13d.
Castings	10⅝d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1¼ to 1/7¼
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/– to 30/–
,, furnace	19/– to 20/–
Durham foundry	19/– to 22/–
,, furnace	16/6 to 17/9
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/2 to 19/2
,,	28×20	,,	36/4 to 38/4
,,	20×10	,,	26/– to 26/3
,,	18¾×14	,,	18/6 to 18/9
C.W.	20×14	,,	15/6 to 16/6
,,	28×20	,,	33/– to 33/6
,,	20×10	,,	23/– to 24/–
,,	18¾×14	,,	16/– to 17/–

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Mar. 7 ..	28	0	0	No	change
„ 8 ..	28	1	3	inc.	1/3
„ 11 ..	28	5	0	„	3/9
„ 12 ..	27	17	6	dec.	7/6
„ 13 ..	27	13	9	„	3/9

Electrolytic Copper

	£	s.	d.		
Mar. 7 ..	31	0	0	dec.	5/–
„ 8 ..	31	5	0	inc.	5/–
„ 11 ..	31	5	0	No	change
„ 12 ..	31	0	0	dec.	5/–
„ 13 ..	31	0	0	No	change

Standard Tin (cash)

	£	s.	d.		
Mar. 7 ..	216	0	0	inc.	15/–
„ 8 ..	217	10	0	„	30/–
„ 11 ..	217	0	0	dec.	10/–
„ 12 ..	218	15	0	inc.	35/–
„ 13 ..	219	0	0	„	5/–

Tin (English ingots)

	£	s.	d.		
Mar. 7 ..	216	5	0	inc.	12/6
„ 8 ..	219	5	0	„	60/–
„ 11 ..	217	10	0	dec.	35/–
„ 12 ..	219	0	0	inc.	30/–
„ 13 ..	219	10	0	„	10/–

Spelter (ordinary)

	£	s.	d.		
Mar. 7 ..	11	10	0	No	change
„ 8 ..	11	10	0	„	„
„ 11 ..	11	10	0	„	„
„ 12 ..	11	11	3	inc.	1/3
„ 13 ..	11	12	6	„	1/3

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Mar. 7 ..	14	2	6	No	change
„ 8 ..	14	2	6	„	„
„ 11 ..	14	2	6	„	„
„ 12 ..	14	3	9	inc.	1/3
„ 13 ..	14	3	9	No	change

Zinc Sheets (English)

	£	s.	d.		
Mar. 7 ..	21	10	0	No	change
„ 8 ..	21	10	0	„	„
„ 11 ..	21	10	0	„	„
„ 12 ..	21	10	0	„	„
„ 13 ..	21	10	0	„	„

Lead (English)

	£	s.	d.		
Mar. 7 ..	12	10	0	inc.	5/–
„ 8 ..	12	10	0	No	change
„ 11 ..	12	10	0	„	„
„ 12 ..	12	10	0	„	„
„ 13 ..	12	10	0	„	„

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 0	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 6	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 8
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 3 6	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 2 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 6	0 15 5½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6½	1 1 3	1 1 5	1 0 9½
1911	1 2 2½	1 2 6	1 2 6	1 1 11½	1 0 11½	1 0 6	0 19 6	0 19 0	0 19 1½	0 19 6	1 0 0½	1 1 6½	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1½	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 5½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 5½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 2	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	} Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 0½	1 5 2	1 4 8½	1 4 6	1 4 0	1 3 6	1 3 0	1 3 0	1 3 0	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6	1 1 0	1 1 6	1 1 6	—	1 1 4½
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 0	1 1 0	1 1 0	1 1 0	1 1 0	1 1 7½
1928	1 1 0	1 1 1½	1 1 11	1 2 4½	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 2½
1929	1 2 6	1 2 0½	1 2 11½	1 3 0	1 3 0	1 3 2½	1 4 0	1 4 8½	1 4 7½	1 4 6	1 4 6	1 4 3	1 3 7½
1930	1 3 3½	1 2 6	1 1 9	1 1 6	1 0 10½	1 0 0	1 0 0	0 19 6	0 19 0	0 17 4½	0 16 4½	0 16 4½	0 19 10½
1931	0 16 1½	0 16 0	0 16 0	0 15 11½	0 15 4½	0 15 0½	0 14 10½	0 14 3½	0 14 6	0 16 8½	0 17 0½	0 16 6	0 15 9
1932	0 16 6	0 16 6	0 16 3	0 15 6	0 15 4½	0 15 0	0 14 11	0 14 8½	0 14 6	0 14 6	0 14 9	0 15 1	0 15 3½
1933	0 15 6	0 15 3	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 11½	0 16 6	0 16 6	0 15 7½
1934	0 16 6	0 17 6	0 16 9	0 16 6½	0 16 8½	0 16 9½	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 16 10½
1935	0 17 0	0 17 4½	—	—	—	—	—	—	—	—	—	—	—

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WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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XUM

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ADVERTISER seeks responsible position in foundry making rain-water and sanitary castings. Has had experience as foundry foreman and foreman patternmaker.—Box 174, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GENERAL Engineering, Grey Iron, Foundry Manager, age 38, desires change, with more progressive foundry. Rate-fixing, estimating and general foundry knowledge (practical moulder 15 years—floor). Moderate salary, increased with results.—Box 200, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

YOUNG Foundryman (30), fully experienced light- and medium-weight castings, desires position as Foreman or Rate-fixer. Willing to demonstrate.—Box 192, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Foreman Patternmaker wanted for one of the largest steel foundries in the country, primarily for the purpose of checking up patterns for production.—State age, experience and salary required to Box 194, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CHEMIST wanted, to take charge of works laboratory: some knowledge of heat-treatment desirable.—Apply by letter, stating age, experience and salary required, to BRADLEY & FOSTER, LIMITED, Darlaston.

REPRESENTATIVES required for London area and the South, Midlands, N.-E. Coast and Scotland (commission basis to commence), by well-known foundry-equipment manufacturers.—Box 198, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

LIGHT-CASTINGS Trade.—Position required as Foreman or Assistant. Experience with first-class light-castings firms, also malleable experience. Technical training. (256)

FOREMAN or Assistant Foreman. Position required by young moulder with supervisory experience in iron and steel works plant and general engineering castings. Understands cupola practice and is technically trained. Position with prospects and opportunities of experience desired. (257)

STEEL-FOUNDRY Foreman requires position. Experience in alloy-steel castings. Heavy shipping, valve, locomotive and general engineering. Estimate all foundry operations. (258)

IRONFOUNDRY Foreman seeks re-engagement. Thoroughly experienced in light castings on most up-to-date plant, including mechanisation. Sound technical training; would take full charge or any situation offering prospects. (259)

MACHINERY

ONE 3-ft. 0-in. Cupola for Sale, with drop-bottom, wind-belt and blower; in good condition. Cheap.—A. HAMMOND, 14, Australia Road, Slough.

FOR Sale, 6-ton Overhead Hand Travelling Crane, span 37 ft.; £30.—Apply, E. HIND, Imperial Works, South Bank-on-Tees.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

PNEUMATIC MOULDING MACHINES

406 Osborn Jolt Rollover.
78-in. x 48-in. Britannia Jolt Rollover.
58-in. x 52 in. Macdonald Jolt Rollover.
36-in. x 24-in. Macdonald Jolt Rollover.
24-in. x 16-in. Macdonald Jolt Rollover.
36-in. x 18-in. Tabor Jolt Rollover (Portable).
48-in. x 24-in. Tabor Jolt Rollover (Portable).
18-44 Type Nicholls Jolt Squeezer.
Several Small Jolt Pinlift Machines.
Several Plain Jolt Machines (all sizes).
Several Small Power Squeezers (Split Pattern).

ALL above are in stock.
are *tested* and guaranteed.
would be sent on approval.
are offered on deferred payment system if desired.
can be seen at work.

I am willing to accept other plant *in exchange*.

ALEX. HAMMOND,
14, Australia Road, SLOUGH

FOR Sale, 30-cwt. 2-phase Electrode Electric Steel-melting Furnace complete with Transformers of total capacity of 800 k.v.a. designed to transform primary current at 6,500 volts, 50 periods down to 2-phase current at 90 v. and 70 v. on open circuit. Only been used nine months. Would suit ironfoundry making alloyed or high-duty cast iron. Cost about £6,000; would sell for £600 f.o.b. Belfast.—Details from W. G. WYLLIE & COMPANY, LIMITED, 68, Gordon Street, Glasgow, C.1.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Fridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

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CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

New Vert. Single-Ram PUMP. 150' 0" head: 20 galls. p.m.: 2" dia. suc. and del.: 4½" dia. ram, 4" str.; belt-dr.

Jar Ram Turnover MOULDING MACHINE (Ajax), for 19" x 15" boxes.

8-cwt. Ungeared Tipping LADLE, inside dia. 24" at top, 20" at bottom.

5 LANCS BOILERS, 30' x 8', 100 lbs. w.p.

Write for "Albion" Catalogue.

Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

FOR Sale, 2 new Zimmermann U.G.O. Straight Draw Moulding Machines, Changed for Turn-overs. List price over £100. Accept best cash offer over £80.—Box 196, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR Sale, Jackman No. 4 Cupola, rated capacity 6 7 tons; in good condition; £75.—Apply, E. HIND, Imperial Works, South Bank-on-Tees.

MISCELLANEOUS

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—FURMSTON & LAWLOR, Letchworth.

FOUNDRY SUPPLIES.—Our two lines, Wax Core Vents and Iron Cement. Highest qualities, lowest prices; quick despatch.—WILLIAM OLSEN, LIMITED, Cogan Street, Hull.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

PATTERNS.—For intricate cored work in mahogany, to fine limits; cylinders, exhaust and inlet pipes, valves; at keenest prices, or cheap jobs in pine, send inquiries to G. T. SPINKS, 53A, Barker Gate, Nottingham.

'Phone: 287 SLOUGH

MOULDING MACHINES

406 OSBORN jolt rollover.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.
HAND Machines taken in part payment for above or exchanged.
EXTENDED PAYMENTS ARRANGED.

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel.
Small Tilghman rotary table sandblast.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

WHEN THINKING OF
SANDBLAST
THINK OF
RICHARDSON'S
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We Supply Re-Conditioned & New
SAND BLAST PLANTS
AND
AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.

Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.